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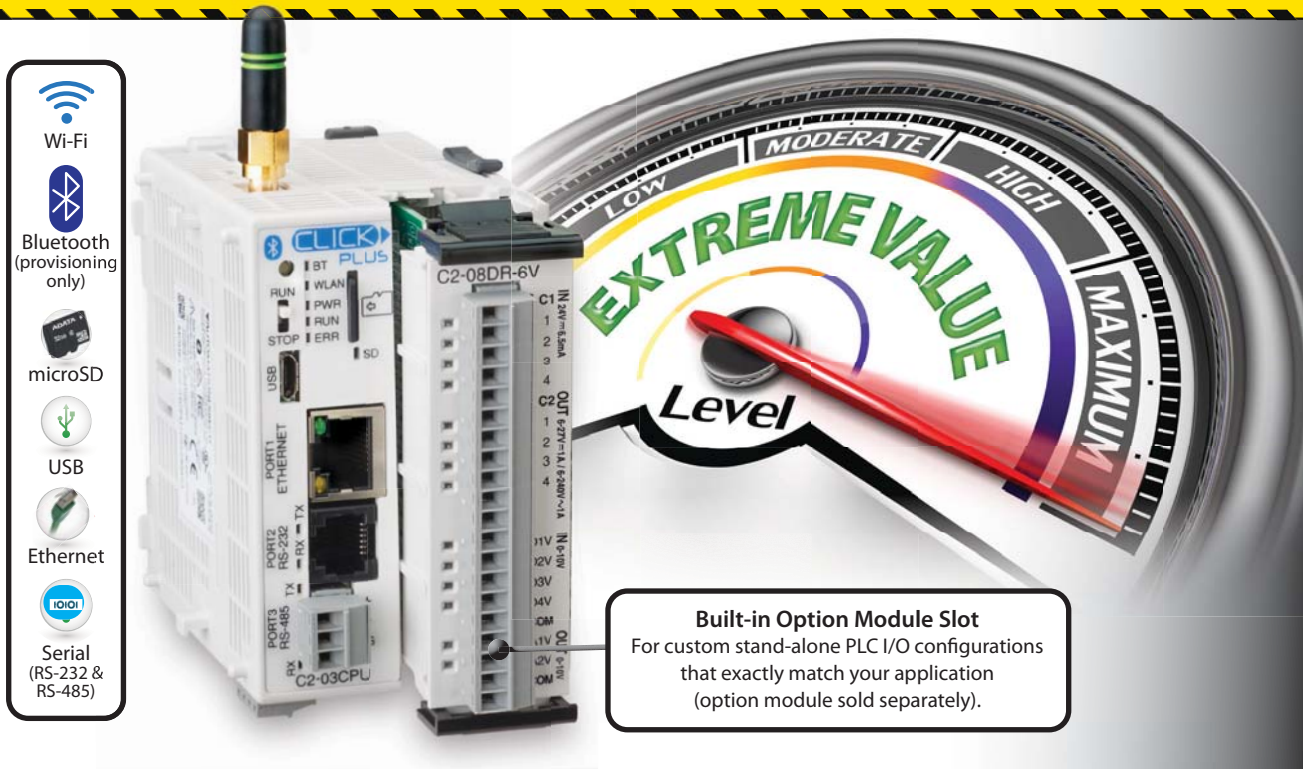

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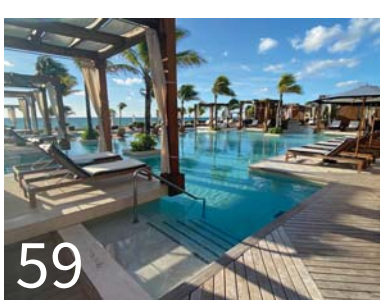

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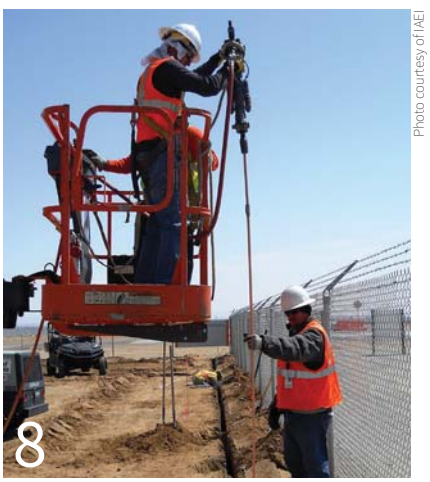

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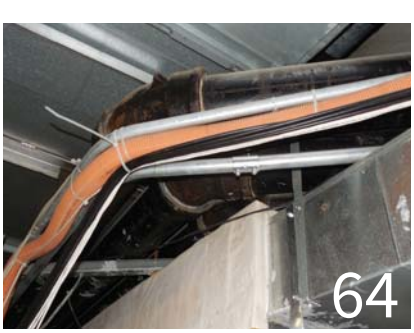
DEPARTMENTS



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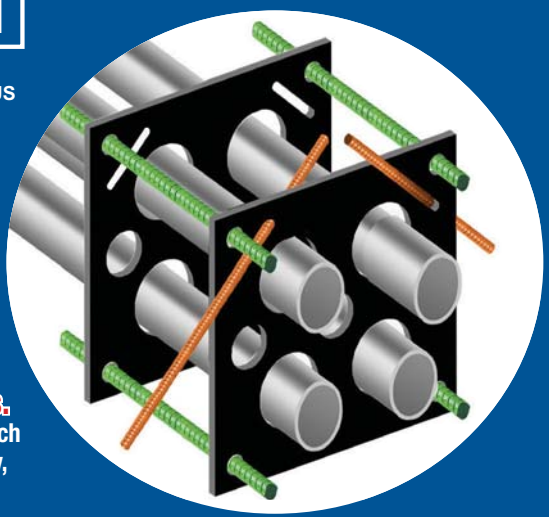

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EC&M's Top 40 Electrical Design Firms Shatter Revenue Expectations

By Ellen Parson, Editor-in-Chief

Based on *EC&M*'s 2023 Top 40 survey results (collected and tabulated in April), it's fair to say things are definitely alive and well in the electrical design world. Coming off of last year, design engineering firms reported impressive revenue gains (13% higher than the previous year), strong hiring interest, and solid progress on the return to normalcy following the pandemic while still operating somewhat in recovery mode. This year, Top 40 firms shattered revenue expectations, pulling in $3.918 billion as a collective group (determined from 2022 data) — a 22% increase from the previous year's results.

Let's take a look at some highlights from this year's survey to put this tidal wave of growth into perspective. After two years of rather subdued activity during the pandemic, Top 40 firms and their clients obviously kicked into high gear in 2022, making up for lost time and capitalizing on what had become a considerable backlog of work. One of the most powerful stats coming out of this year's results that immediately jumped out to me is the fact that 37 out of 40 firms making the Top 40 list maintained their revenue level from the previous year while nearly all reported gains. If you take out the two firms that made the list for the first time this year (they had no historical data to compare to), that leaves only one firm reporting a decline! I can confidently say that this has never happened before in the history of our survey, which dates back to the mid 2000s. Another noteworthy finding is 91% of firms rated the 2022 business climate as "strong" — a dramatic shift in sentiment from 57% in 2022 and 30% in 2021. Read the full special report, written by Freelancer Tom Zind, starting on page 14, for more analysis and to view the complete rankings table.

Now for the million dollar question: How long can these good times last? The answer varies, depending on whom you talk to and which source you cite. I feel like we've been bracing for an "imminent" recession forever, yet there's still no consensus on whether or not it's actually arrived. Inflation did hit a 40-year high in 2022, and interest rates continue to rise, resulting in a tightening of credit. The job market remains strong at the moment with relatively low unemployment. Add in a few bank failures and a near default on the U.S. debt ceiling (the Senate approved a measure on June 2, 2023 that will suspend the nation's debt limit through Jan. 1, 2025), and you've got the makings for one complicated economic forecast.

According to survey results released from the ACEC Research Institute (the independent research arm of the American Council of Engineering Companies) on June 9, the outlook for the overall economy is improving among the nation's leading engineering firms as CEOs are "extremely optimistic" for strong economic performance in 2023.

"Today's report is good news for our industry and good news for the nation's economy. The long-term federal investments in American infrastructure and manufacturing are surely a large reason why these engineering leaders are so optimistic," said ACEC President and CEO Linda Bauer Darr in the press release. "America's engineering industry serves a broad spectrum of our economy, from transportation and water to energy, housing, industrial and manufacturing facilities, health care and more. If these firms are busy now and hopeful for the future, that's a good indication that the broader economy is moving in a positive direction."

Ellen Parson

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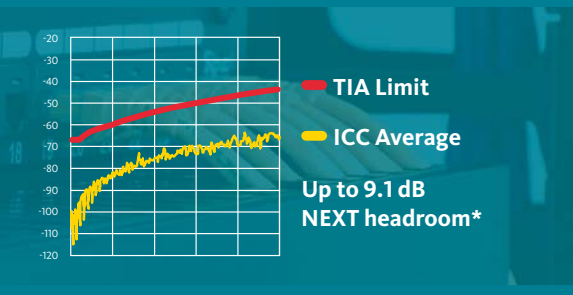

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NEC Requirements for Grounding Electrode Systems

Learn about Sec. 250 requirements for electrical installers.

By Joseph Wages, Jr., IAEI

Based on the 2020 NEC.

The grounding electrode provides the essential function of connecting the electrical system and electrical equipment to the earth. In some cases, the grounding electrode(s) serves to ground both the electrical system and the equipment to earth (grounded system). In other cases, the grounding electrode only connects the equipment to the earth (ungrounded system). In both situations, the primary purpose of the grounding electrode(s) is to maintain the electrical equipment at the earth's potential present where the grounding electrode(s) is located. The earth's potential is assumed to be zero.

Another function of the grounding electrode(s) is to dissipate overvoltage into the earth. Overvoltages can be caused by high-voltage conductors being accidentally connected to the lower-voltage system, such as by an internal failure in a transformer or by an overhead conductor dropping on the lower-voltage conductor. Overvoltage can also be caused by lightning.

In today's homes, appliances containing microprocessors have become increasingly prevalent. Section 250.24(D) requires "…the equipment grounding conductors, the service-equipment enclosures, and, where the system is grounded, the grounded service conductor to be connected to the grounding electrode(s) required by Part III…" of Art. 250.

Section 250.50 requires that all grounding electrodes that are present at each building or structure served be bonded together to form the grounding electrode system. This generally means that where metallic water piping meeting the requirements of Sec. 250.52(A)(1), metallic in-ground support structure meeting the requirements of Sec. 250.52(A)(2), or a concrete-encased electrode meeting the requirements of Sec. 250.52(A)(3) is part of the construction of the building or structure, it is used as part of the grounding electrode for the electrical system (**Fig. 1** on page 10).

Photo courtesy of IAEI

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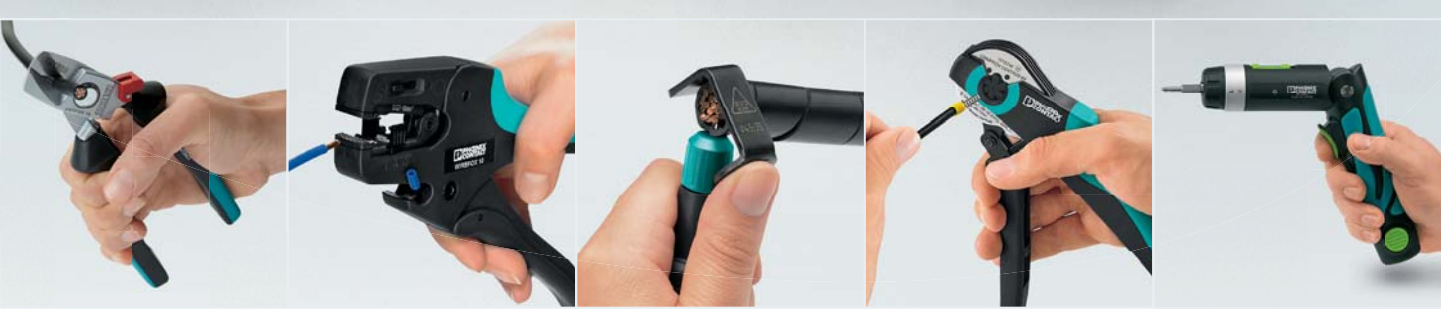

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ITEMS PROHIBITED AS GROUNDING ELECTRODES

There are some things that cannot be used or are prohibited from being used as grounding electrode(s) (**Fig. 2**). This may not have always been true in earlier editions of the NEC. For the 2020 edition of the NEC, the following three items are prohibited from being used as a grounding electrode:

- Underground metal gas piping systems are not permitted to be used as grounding electrodes. This does not eliminate the requirement that metal gas piping systems installed in or on buildings or structures be bonded.
- Conductive objects made from aluminum also are not permitted to be used because aluminum would corrode in many types of soil and become ineffective as an electrode.
- The metallic elements making up a swimming pool shell or frame are not to be used as a grounding electrode for the premise's power system.

AN ELECTRODE TYPICALLY INSTALLED BY ELECTRICAL INSTALLER

This article cannot cover all the various grounding electrodes, so let's discuss a particular type installed by an electrical professional. As previously stated, the water pipe, in-ground support structure, and concrete-encased electrodes are installed by other trades. Where electrodes that are described in Sec. 250.52(A)(1) through (A)(7) do not exist at the building or structure served, a grounding electrode or electrode system is required to be installed and utilized.

Let's briefly discuss rod and pipe electrodes. Section 250.52(A)(5) requires that these electrodes not be less than 2.44 m (8 ft) in length and consist of the following materials:

- Pipe or conduit not to be smaller than metric designator 21 (trade size ¾) and, where made of steel, to have the outer surface galvanized or otherwise metal-coated for corrosion protection.
- Rod-type to be of stainless, copper, or zinc-coated steel and at least 15.87 mm (⅝ in.) in diameter unless listed.

Section 250.53(A) requires rod and pipe electrodes to be installed in contact with the soil at least 2.44 m (8 ft). They

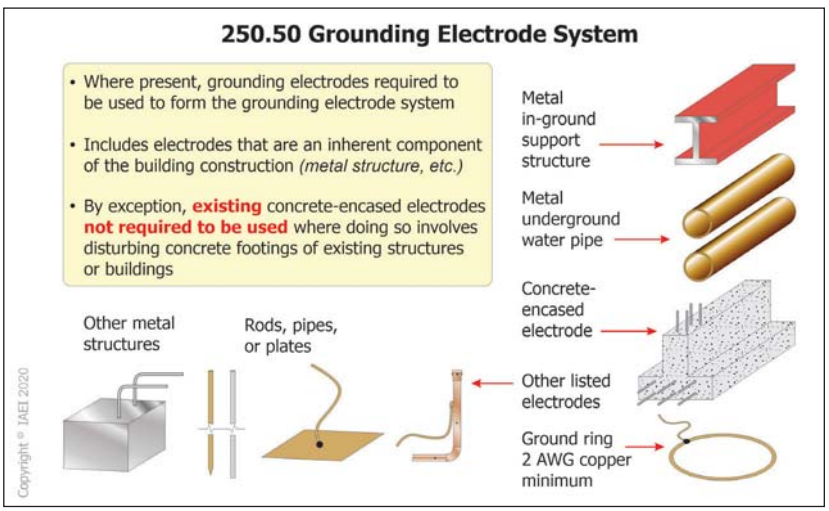

Fig. 1. NEC Sec. 250.50 provides requirements for bonding grounding electrodes together to form a grounding electrode system.

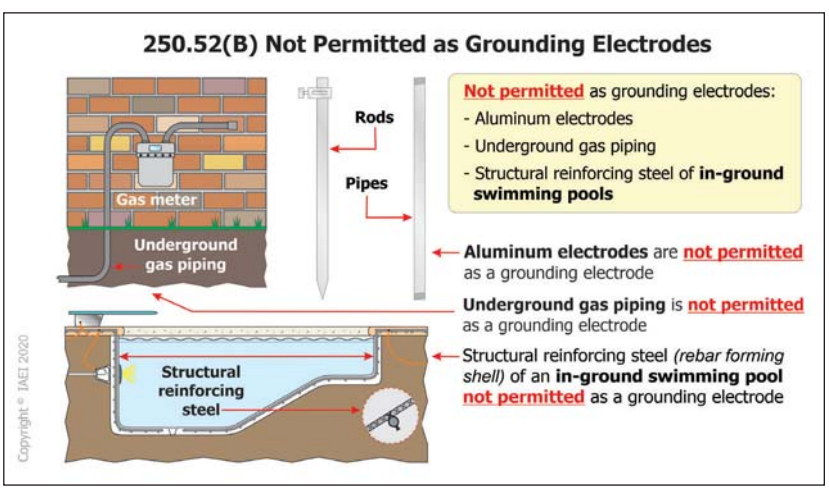

Fig. 2. Section 250.52(B) lists items that cannot be used as grounding electrodes.

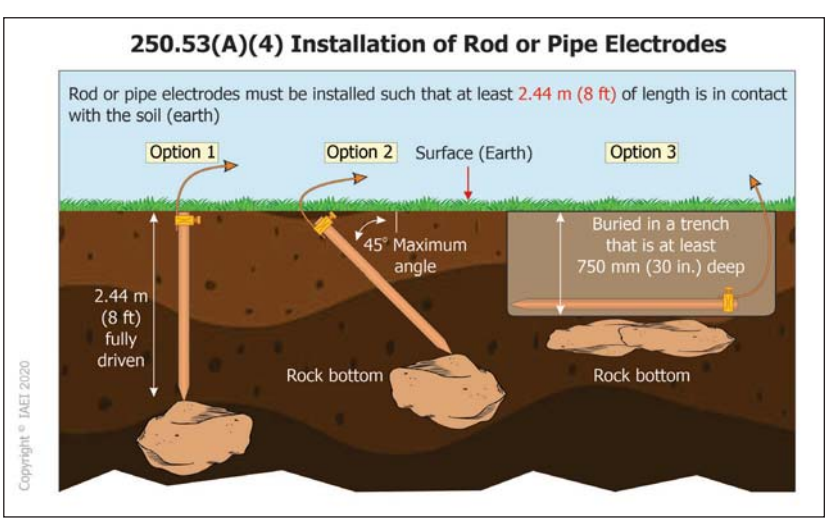

Fig. 3. Refer to Sec. 250.53(A)(4) for installation requirements of rod or pipe electrodes.

are to be driven vertically unless a rock bottom is encountered. If rock bottom is encountered that prevents the rod from being driven 8 ft vertically, it is permitted to be installed at an oblique angle of not more than 45° from vertical. Where a rock bottom is encountered at an angle up to 45°, which prevents the rod from being installed, only then can the rod or pipe be buried in a trench that is at least 750 mm (30 in.), as seen in **Fig. 3** on page 10.

The upper end of the rod is to be flush with or below ground level unless the aboveground end of the rod, and the grounding electrode conductor attachment is protected from physical damage. This will require that a ground rod longer than 8 ft be used if any part of the rod is exposed above ground level. Since an 8 ft ground rod or pipe must be driven the entire length, the ground clamp is required to be listed for direct earth burial.

Where more than one of the rods is installed to form a grounding electrode system, Sec. 250.53(B) requires that spacing between them be a minimum of 1.83 m (6 ft). This minimum spacing is to ensure both electrodes provide a connection to the earth without interfering with each other. While this spacing is the NEC minimum, other standards such as IEEE recommend the minimum spacing of rods be at least equal to the depth the electrode is driven.

As can be seen by the **Photo** on page 8, driving ground rods can be difficult work depending on what part of the country you are located in. Installation of these components of a grounding system needs to be done correctly and in compliance with the NEC. The safety of the building or structure depends on you. EC&M

Joseph Wages, Jr., is the director of digital education for IAEI. He represents IAEI on NFPA's NEC Code Making Panel-2 for the 2020 NEC. He also serves on the UL Electrical Council and on several UL Technical Standard Panels. Wages, Jr., is an ICC certified building official and an IAEI certified electrical inspector for one- and two-family dwellings. He can be reached at jwages@iaei.org.

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Helping Customers Understand the Value of Outdoor Lighting

Five outdoor lighting ideas electrical contractors can offer homeowners for increased peace of mind

By Adam Mack, Lutron

For homeowners, there's no better feeling than the peace of mind of driving home after dark and finding their property illuminated by a well-placed outdoor system or the enjoyment of late summer and early fall evenings in the beautiful soft glow of twinkling lights.

Practically speaking, lights can make a home safer and less attractive to criminals. According to the FBI, a home break-in occurs in the United States every 26 seconds, making outdoor lighting a necessity.

And, if you have customers thinking of selling their homes, most real estate agents agree outdoor lighting increases a property's value by creating the perception that a house's livable space extends to the outside.

While almost every home has some form of outdoor lighting, new technology allows customers to increase the function of their exterior lights. You can teach your residential customers about what's available to increase the attractiveness, security, and value of a home through lighting designed for the outdoors. In the process, you can grow your business by highlighting relatively simple steps that can make a big impact.

Here are five ideas that can help homeowners to see the (outdoor) light.

Outdoor lighting can make your customer's homes look good and feel safe.

ENCOURAGE YOUR CLIENTS TO THINK IN ZONES.

One of the first and most important steps is to discover how your customer uses their outdoor space and recommend the best light for each area. Visit your customer's home at dusk, and take a walk around their yard. Creating different zones is the ideal way to create a comfortable outdoor area while ensuring homeowners have the right light to meet their needs. Brighter lights work well for an outdoor kitchen, bar, or grilling area, while warm lights and cozy seating encourage relaxing and visiting with friends. Uplighting draws attention to a special landscaping feature. A current trend is moonlighting, in which soft lights are installed high in trees or

other structures to cast a silvery glow that looks like moonlight.

INTRODUCE LAYERING USING A COMBINATION OF LIGHTING SOLUTIONS.

Layering light is another way to help homeowners create a warm, welcoming outdoor space — and it can increase the area's functionality and flexibility. There are three main types of lighting layers. Ambient light is the most basic and highly functional of the three. It's the general light you get when you turn on a switch to find your way around. Accent light highlights a specific feature, like a backyard waterfall or a special tree. Finally, task lighting is a practical, focused light needed to do a specific task, such as cooking or reading.

ADD LIGHTING SOLUTIONS TO WALKWAYS AND STAIRS.

Path lighting provides residents and guests with increased safety and peace of mind. It's a necessity that can also make your customer's yard more inviting. Low-voltage or even solar-powered solutions work well to provide the soft light needed to illuminate stairways and other garden paths. When lighting a customer's pathway, consider placing lamps 10 to 15 feet apart, staggering them on both sides of the walkway. This will create the right lighting to guide their path without causing glare or too much brightness.

PROGRAM YOUR CUSTOMERS' LIGHTS.

One benefit of smart outdoor lighting is never having to drive up to a dark house. Programmable outdoor lights give the homeowner fewer things to worry about. They can also help save money on energy bills. Your customers may choose to leave pathway lighting on all night while turning off other lights not being used. It's particularly handy when homeowners are on vacation, making a home look lived in and deterring crime.

KEEP IN MIND A FEW PRACTICAL TIPS WHEN RECOMMENDING AND INSTALLING OUTDOOR LIGHTING.

Make sure the lighting and lighting controls are graded for outdoor use and low voltage; the National Electrical Code requires all outdoor outlets to be ground-fault protected. Look for products that are durable and withstand wind, rain, and dust. It will be worth it in the long run, instead of replacing inexpensive products every year or so.

By implementing some — or all — of these tips, you can delight your customers and grow your business. EC&M

Adam Mack is the product manager for Caséta by Lutron. He holds a degree in mechanical engineering from Lehigh University. He can be reached at ammack@lutron.com.

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By Tom Zind, Freelance Writer

A TIDAL WAVE OF REVENUE

Business washed up on Top 40 Electrical Design Firms' doorsteps in 2022, but the flood of revenue carried in some challenges that continue into 2023.

The good old days — and then some — returned to the electrical design world in 2022. After two years of subdued activity during the COVID-19 pandemic, electrical design firms appear to have gotten back to business last year, dusting off projects placed on hold and helping action-starved clients make up for lost time. Evidence of that big snapback comes from *EC&M*'s annual survey of electrical design firms that yields its Top 40 Electrical Design Firms ranked by prior-year revenues (see **Rankings Table** on page 16). This year's Top 40 had combined reported electrical design revenue of $3.918 billion in 2022. That was 22.2% higher than the combined prior-year revenues of last year's Top 40, which came in at $3.204 billion (based on 2021 revenue numbers). All firms but one reported higher revenue; the range was an increase of 145% and a decline of 7%. A year earlier, six of the returning Top 40 reported year-over-year decreases.

No surprise, then, that 91% of firms rating the 2022 business climate

Photo courtesy of Salas O'Brien

Salas O'Brien partnered with the Metropolitan Washington Airports Authority (MWAA) to upgrade the electrical system at Dulles Airport's Concourse C/D, a project requiring zero operational downtime.

Power Design delivered multi-trade design-build on this stunning residential mixed-use high rise in Washington, D.C.

Photo courtesy of Mo Lelii

Top 40 Electrical Design Firms					
2023 Ranking	2022 Ranking	Company	Location	Revenue Specifically Related to Electrical Design Work in 2022 (millions)	% Change (2021 to 2022)
1	1	Burns & McDonnell	Kansas City, Mo.	$932.1	38.0%
2	2	Black & Veatch	Overland Park, Kan.	$717.1	26.1%
3	3	Stantec, Inc.	Edmonton, Alberta, Canada	$329.4	9.0%
4	4	Tetra Tech, Inc.	Pasadena, Calif.	$252.0	12.0%
5	5	Mott MacDonald	Iselin, N.J.	$225.9	14.6%
6	6	Mesa Associates, Inc.	Madison, Ala.	$165.0	22.2%
7	7	Ulteig Engineers	Fargo, N.D.	$125.6	23.0%
8	12	Salas O'Brien	Irvine, Calif.	$101.8	76.7%
9	NL	IMEG	Rock Island, Ill.	$81.3	NA
10	8	Henderson Engineers	Lenexa, Kan.	$80.0	0.0%
11	10	Stanley Consultants	Muscatine, Iowa	$68.5	1.2%
12	11	M.C. Dean	Tysons, Va.	$68.1	16.6%
13	15	Hazen and Sawyer	New York	$54.6	29.7%
14	14	Burns Engineering	Philadelphia	$46.1	8.2%
15	18	Brown and Caldwell Engineering	Walnut Creek, Calif.	$44.8	23.4%
16	16	CHA Consulting, Inc.	Albany, N.Y.	$43.9	17.4%
17	13	Affiliated Engineers, Inc.	Madison, Wis.	$42.2	-6.8%
18	17	Syska Hennessy Group	New York	$41.2	12.3%
19	19	Commonwealth Associates, Inc.	Jackson, Mich.	$37.4	16.5%
20	24	NEI Electric Power Engineering	Lakewood, Colo.	$35.6	61.1%
21	20	Faith Technologies, Inc.	Menasha, Wis.	$34.8	8.7%
22	21	Gannett Fleming	Camp Hill, Pa.	$33.6	15.5%
23	22	Jaros, Baum & Bolles (JB&B)	New York	$30.3	17.9%
24	30	HED (Harley Ellis Devereaux)	Detroit	$27.0	97.1%
25	26	TLC Engineering Solutions	Orlando, Fla.	$26.9	37.9%
26	38	Spectrum Engineers	Salt Lake City	$26.5	145.4%
27	23	P2S Inc.	Long Beach, Calif.	$24.5	5.6%
28	33	Power Design, Inc.	St. Petersburg, Fla.	$24.3	97.6%
29	25	RMF Engineering	Baltimore, Md.	$22.0	10.0%
30	27	CDM Smith, Inc.	Boston	$19.4	25.0%
31	28	CannonDesign	New York	$19.0	22.6%
32	31	Smith Seckman Reid, Inc.	Nashville, Tenn.	$16.0	18.5%
33	32	Electric Power Systems (EPS)	St. Louis, Mo.	$15.6	22.8%
34	40	Dunham Associates	Minneapolis	$15.5	56.6%
35	34	Interstates, Inc.	Sioux Center, Iowa	$14.1	16.5%
36	NL	DLR Group	Minneapolis	$13.6	NA
37	36	Core States Group	Duluth, Ga.	$13.3	8.8%
38	39	The Engineering Enterprise	Alameda, Calif.	$13.0	30.0%
39	39	Mazetti	San Francisco	$12.4	42.5%
40	35	Concord Engineering Group, Inc.	Voorhees, N.J.	$12.0	0.0%

Notes:

List based on proprietary survey. To get on the list to receive the survey for next year, please contact Editor-in-Chief Ellen Parson at eparson@endeavorb2b.com or call (816) 560-6448.

NL - Not listed. This company did not appear in last year's electrical design services revenue listing.

NA - Not available.

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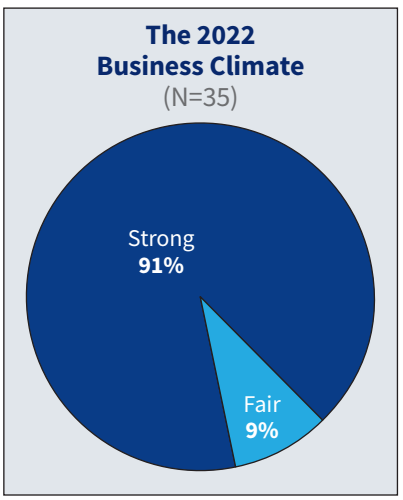

Fig. 1. The number of firms characterizing the current business climate as "strong" skyrocketed this year, increasing from 57% in 2022 (which was 30% higher than the year before) to 91% in 2023 (based on 2022 revenue numbers).

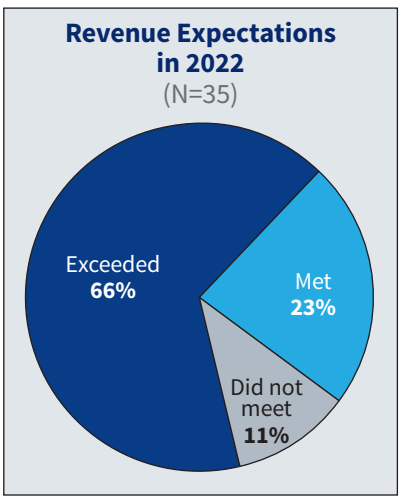

Fig. 2. Unlike last year, when the number of firms "meeting" revenue expectations surpassed the number of respondents reporting that they'd "exceeded" expectations, this year optimistic forecasts bounced back — with 66% of respondents expecting to exceed expectations compared to 43% in 2022.

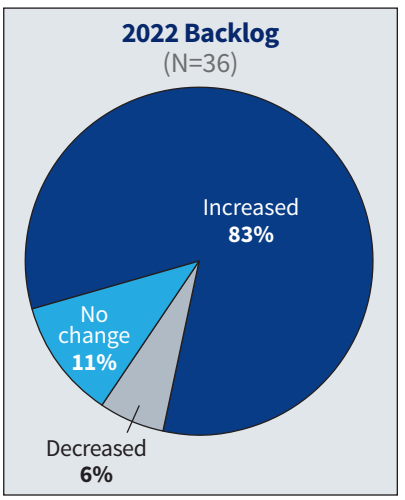

Fig. 3. The numbers here remained steady. A total of 11% of firms reported no change in backlog this year as opposed to 14% last year. The number of firms reporting an increase in 2022 was 83% compared to 86% in 2021.

described it as strong (**Fig. 1**) — a big shift in sentiment from the last two years. Last year, 57% said the prior year's climate was strong, up from a dismal 30% the year earlier. Clearly, something changed, most likely the receding of the disruption and uncertainty caused by the pandemic and the surge in activity as demonstrated in a strong revenue rebound. All was not great in 2022, of course, with rising inflation and supply chain issues impacting business, but design firms may have simply been drawing comparisons with the COVID-19 years.

"It was an amazing year, absolutely," says Brian Leavitt, principal and director of electrical engineering at IMEG (No. 9), Rock Island, Ill., "one that the design and construction industry was looking for. Regardless of pricing and materials issues, there was a lot of demand, and almost every category was strong for us."

The overall feel to the year, he says, was one of pushing to get back to normal after the pandemic cloud forced developers to tap the brakes and put growth plans on hold.

"Companies wanted to make up for opportunities lost during COVID, and there was also a surge past that to start pursuing the longer-term goals that they had for these years," he says.

At Boston-based CDM Smith (No. 30), revenues were up 25%, a result of both stalled work resuming and a bigger share that electrical is gaining in the typical project, says Matt Goss, senior vice president and MEP/energy practice leader.

"Things are definitely getting back to normal coming out of COVID, but there's also a new focus emerging on projects that are supported by electrical design work — areas such as renewables, microgrids, and EV charging," he says. "There are more electrical components of jobs and more electrically driven projects, too."

A WELCOME SURPRISE

Last year's growth looks to have caught many companies by surprise. After two years of about a third of companies saying prior-year revenues failed to meet expectations, two-thirds of this year's Top 40 say revenues came in higher than expected (**Fig. 2**) while two in 10 said revenues were in line. Only 11% said revenues disappointed, which was in line with last year's results.

Another sign that last year was good for most design firms is that backlogs surged again — evidence that work was there for the taking, and firms were perhaps eager to lock up and stock up amidst concerns about a possible recession. Like last year, when 86% of firms said backlog grew in the previous year, 83% of this year's ranked companies said 2022 showed an increase (**Fig. 3**). That was a welcome development, considering that only half of the 2021 Top 40 reported an increase in 2020. Of those reporting an increase, half said it was modest, in the 6% to 9% range, though a third said it exceeded 15%.

At Salas O'Brien (No. 8), Irvine, Calif., revenues were up 75%, and backlog increased as the firm continued to reap the benefits of a multi-faceted and long-term expansion program, says Darin Anderson, chairman and CEO. Some three dozen mergers and acquisitions over the past decade have expanded the diversified company's reach and breadth, boosting electrical's share of revenue to about 40% in the process.

"We achieved 19% organic growth last year, partly a result of growing client relations and more cross-selling new built-environment services into those relationships," Anderson says, noting the company wins about 80% of the opportunities it seeks. "At the same time, we're adding to the market sectors we want to grow in by continuing to find more firms to merge and partner with."


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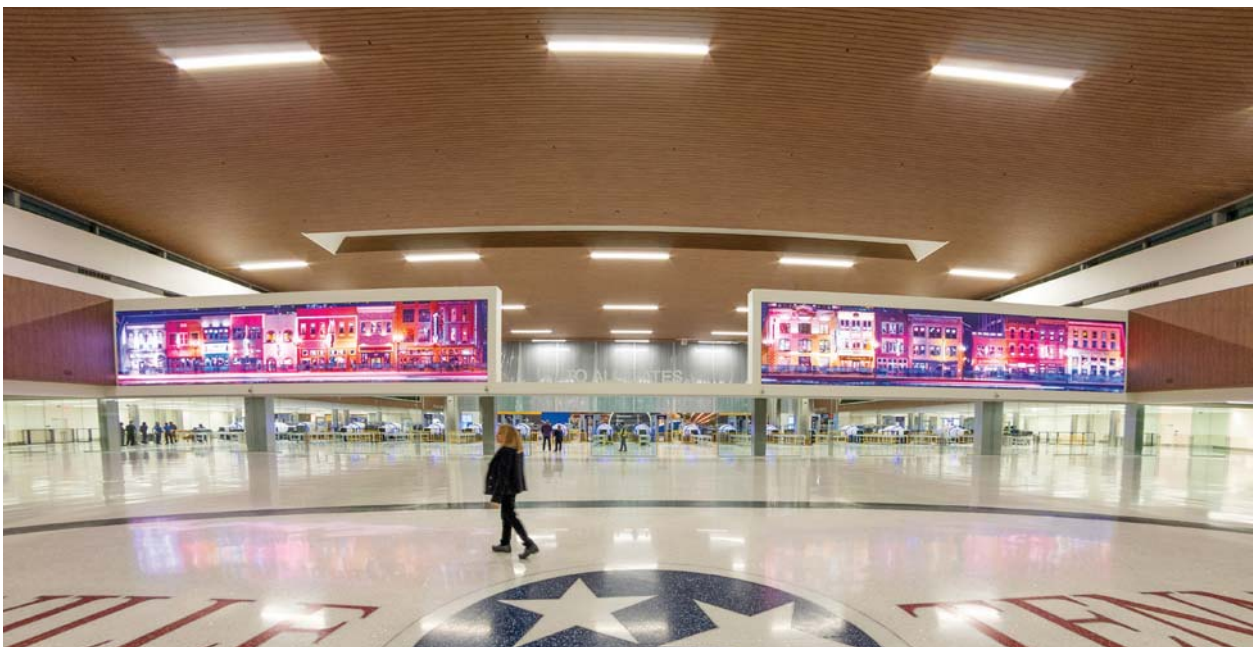

Photos Courtesy of Maxime Roux/Gentilhomme Studio

Two 900-square-foot, 12,000-high-resolution multimedia displays at Nashville International Airport greet passengers with custom artwork that brings the Lower Broadway entertainment district directly into the terminal and celebrates the culture of Middle Tennessee. Burns Engineering was responsible for the security and low-voltage systems engineering and integration for the completely renovated, 200,000-square-foot Grand Lobby.

Revenue growth at Smith Seckman Reid, Inc. (No. 32), Nashville, Tenn., fell back from 50% in 2021 to 19% last year, due in part to many projects' extended duration caused by supply chain issues, says Simon Gandica, electrical discipline resource manager. But both revenue and backlog growth exceeded expectations, making for a solid year.

"A lot of projects that had gone on hold were restarted, but we also benefitted again from ongoing relationship-based business from our loyal clients and trusted partners," Gandica says.

The firm's electrical revenues continued to benefit from recent office expansions into high-growth areas of Texas and the Southeast and strong demand in its focus markets of special "complexity," such as health care, sports, and industrial, says Mario Valentini, electrical discipline resource manager.

As a recovery year of sorts that produced a big revenue pop, 2022 was one that presented opportunities in every direction for many firms. But the year did mostly cement the rankings of "hot" and "cold" markets (see **Table**). Government fell off the headline "hot" list of prior surveys, replaced by manufacturing (also showing up on the cold list) but health care, power, education, and renewables held. Retail, hospitality, and food and beverage, likely still smarting from the pandemic, continued their grip on "cold."

Hottest Market Segments in 2023
1. Health Care
2. Power (Utilities/T&D)
3. Education
4. Renewable (Wind & Solar) (tie)
4. Manufacturing (tie)
4. Data Centers (tie)
Coolest Market Segments in 2023
1. Retail
2. Hospitality
3. Manufacturing
4. Food & Beverage (tie)
4. Aviation (tie)
4. Sports/Recreation (tie)

Again this year, health care retained its No. 1 spot as the hottest market, but power passed education to move into the second spot. Retail bumped hospitality out of the coolest spot, and manufacturing appeared on both lists, demonstrating the diversity of firms' vertical market saturation.

To the mild surprise of Vice President Ryan Cross, commercial and industrial projects picked up at Electric Power Systems (No. 33), St. Louis, as owners opened their wallets in a bet on an

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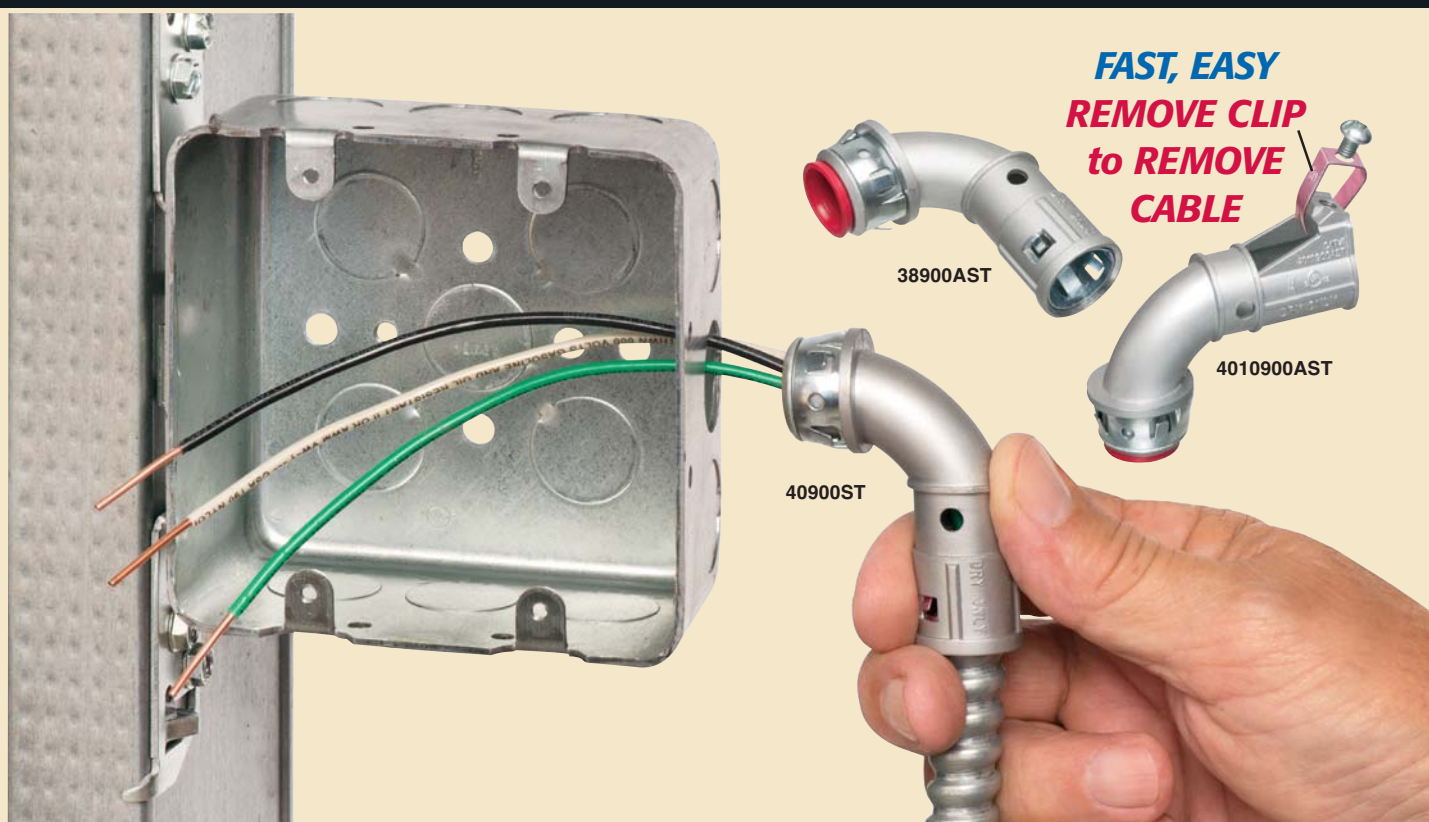

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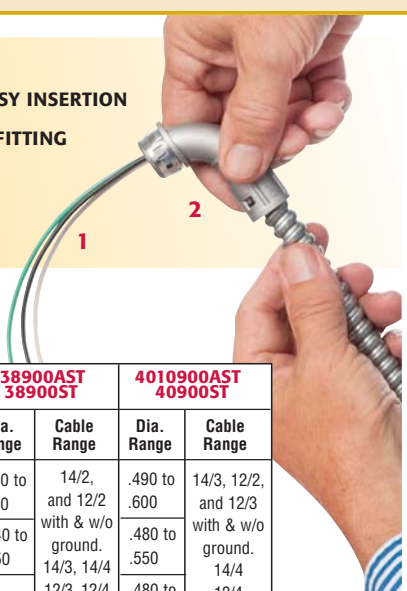

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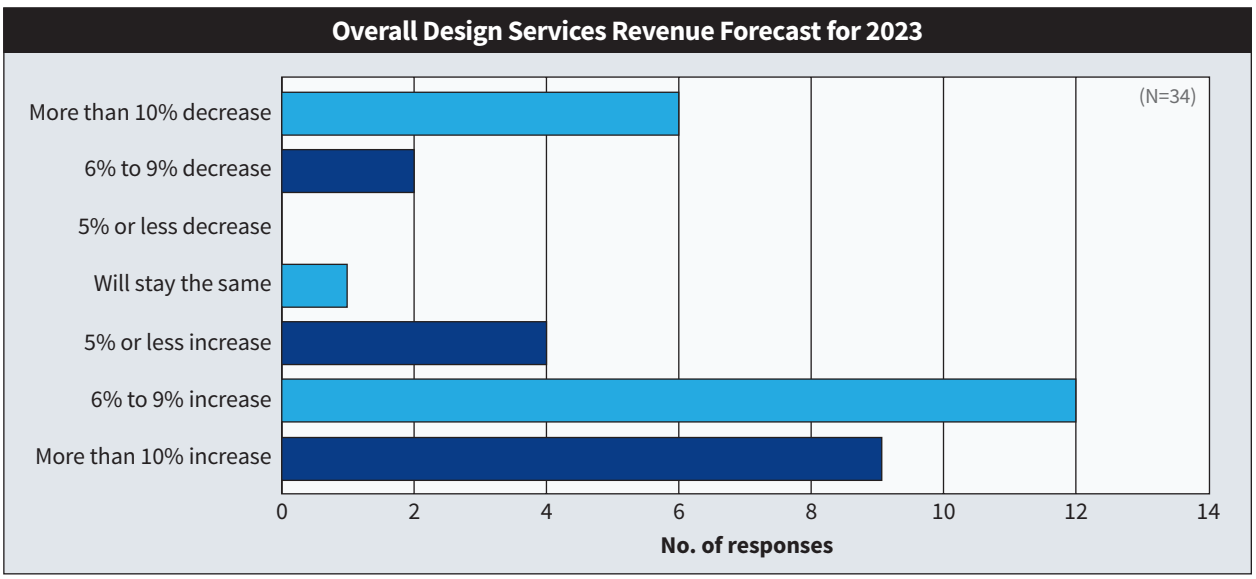

Fig. 4. The number of Top 40 firms expecting an increase in revenue of at least 6% stayed about the same as last year's results. However, what did change in this year's survey was the number of firms expecting a decrease of 5% or more (eight companies compared to three the previous year).

eventual resurgence. It was also another strong year for renewable energy, a focus sector with solid prospects as opportunities for more EPC/turnkey design-build projects play to the company's strengths.

"Only a small number of companies have been able to do that, but now there's a larger pool that we belong to that can," he says. "I think the future is bright there."

A big airport project in its backyard, Kansas City International helped Henderson Engineers (No. 10), Lenexa, Kan., keep its electrical revenues in line with 2021 and further immerse the firm in another emerging market opportunity.

"Aviation, fueled by KCI, was a bigger market for us, one we didn't have much focus on before," says Jason Wollum, chief sector officer, noting that it could follow the pattern of the firm's mounting involvement in electrical-heavy data center/mission critical work.

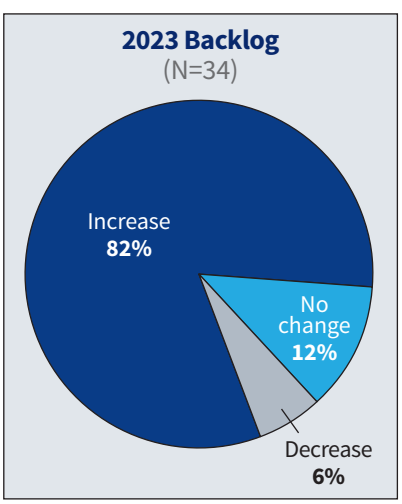

Fig. 5. The number of firms forecasting an increase in backlog for the current year decreased slightly — from 94% in last year's survey to 82% this year. The number of firms expecting no change doubled from the previous year.

BLUE-SKIES SCENARIO

Continued market sector expansion, more electrical work, the sustainability of the "electrification" trend, and the economy's ability to skirt a recession are some key wild cards in electrical design firms' ability to keep the good times going into 2023 and beyond. A repeat of 20% growth might be a stretch, but three-quarters of firms predicting do expect revenues to increase this year (**Fig. 4**), a lower share than projected increases in 2022. And, in line with last year, about 80% see backlog increasing as well (**Fig. 5**), with growth topping out shy of 10% for most.

Philadelphia-based Burns Engineering, Inc. (No. 14) is among the aggressively optimistic, pegging both revenue and backlog gains in the double digits. Philadelphia Region Vice President Michael Walton says the economy's course is a concern, but there are too many positive signs to let those worries take command. With its key markets in high gear, Burns is doubling down on growth, bolstering key offices, staffing up, and concentrating its fire in lucrative endeavors.

"We're taking market share in areas like health care, which is new for us in the past five years, and transit, where the electrification trend is taking hold," he says. "A new national practices leader who was with the Los Angeles metro system is in place now, leading that transit effort. And we're expanding in New York and LA, where we see initiatives around carbon reduction growing."

Salas O'Brien is in the same camp, predicting double-digit revenue and backlog gains on the back of the firm's specialization in areas that are less "commodity-focused," Anderson says, which could be more sensitive to a slowing economy.

"Some of our markets have good tailwinds, and the need for critical infrastructure that we focus on means lower chance of a downturn even though the economy does seem to be slowing," he

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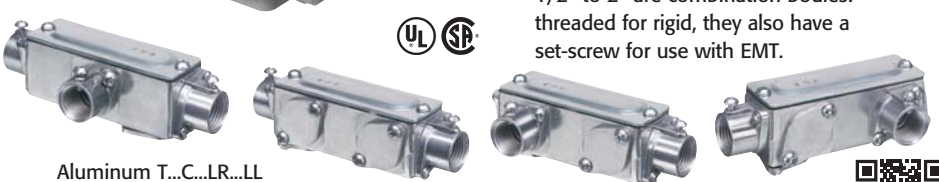

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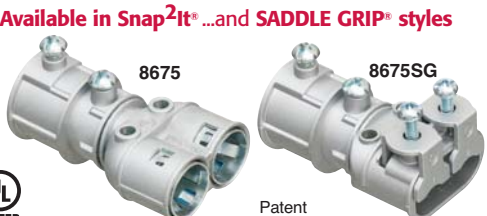

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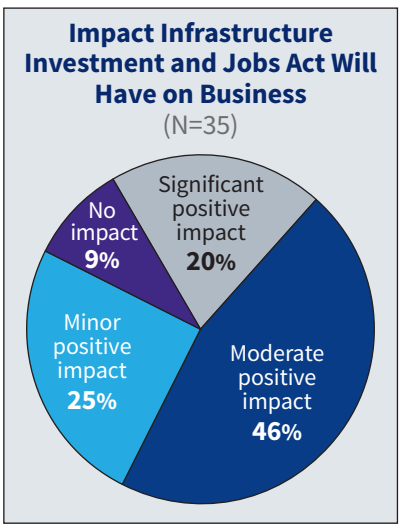

Fig. 6. Like last year, the majority of Top 40 firms (71% this year compared to 70% last year) expect the infrastructure legislation will have either a minor or moderate positive impact on their business. Similarly, 21% last year and 20% this year expect a significant impact.

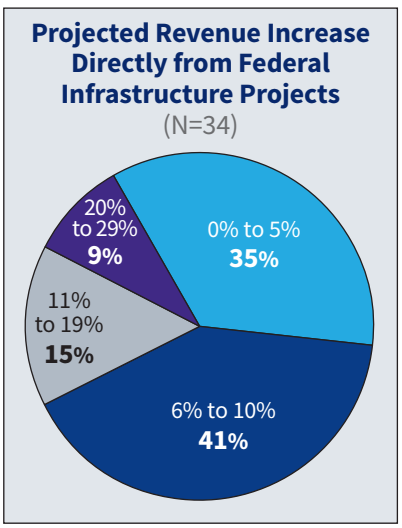

Fig. 7. The tables turned this year on this question. Last year, a little over half of survey respondents (56%) anticipated no more than a 5% revenue increase in new project revenue tied to federal infrastructure funds. This year, that percentage dropped to 35% with 41% expecting up to a 10% boost in business compared to only 22% last year.

says, which will affect developers more subject to interest rate spikes and softer conditions. "So, I think growth continues for us into 2023."

Some of the optimism is likely tied to prospects for higher government spending on infrastructure. Long-term investments in the electrical grid, renewable energy, green buildings, transportation, roads and bridges, and other pillars of a 21st-century economy are already starting to factor into design firms' revenue projections.

Three-quarters of firms weighing in expect the Infrastructure Investment and Jobs Act to have measurable impact on their businesses this year (**Fig. 6**), though most think the effect will be felt on the margins; 76% don't see it exceeding 10%, as shown in **Fig. 7** (though many more of this year's Top 40 expecting a current-year impact say it will be more pronounced). But design firms understand that infrastructure now means more than "roads and bridges," which may have minimal electrical elements. Electric vehicle charging infrastructure and renewable energy drew the most mentions as projects likely to get the biggest boost from federal infrastructure spending this year (**Fig. 8**).

With a strong presence in the public spending sphere and special expertise in water, transportation, and energy, CDM Smith is primed to benefit from more infrastructure spending that could expand to incorporate microgrids, EV charging, and renewable energy — and make this year less dicey, Goss says.

"We'd be more concerned about 2023 if we were doing a lot of work in industrial or commercial markets, but the regulatory/legislatively driven work we do is going to be supported," he says. "We're primarily an infrastructure-based firm, so as that funding trickles out, it should make its way through to us. Up to 20% of our revenues could be tied to that."

As a multi-discipline engineering firm, IMEG's electrical design teams could ride a wave of infrastructure work, Leavitt says. There are already signs of activity through government agencies — "we're seeing the tip of it now" — that hold some promise of extended involvement by the firm that will impact electrical, maybe even lifting 2023 revenues alone by 10% to 20%.

"A lot of the civil work that might come out of this will likely feed into MEP," he says. "We won't pivot the entire organization toward this work because

Sectors Expected to Experience Biggest Boost from Federal Infrastructure Funds

Ranking	Number of votes	Sector
1	22	Electric vehicle (EV) charging infrastructure
2	20	Renewables (solar and wind)
3 (tie)	14	Roads and bridges
3 (tie)	14	Electric grid updates
5	11	Water/wastewater
6	8	Rail, buses, airports, shipping ports
7	6	Broadband/telecom

Fig. 8. Top 40 firms identified several sectors they felt would produce the biggest increase in new project activity in 2023 from federal infrastructure dollars. Moving into the top spot this year, electric vehicle charging infrastructure (followed closely by renewables) passed road and bridge work (the sector that held the top spot last year).

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Factors Having the Most Negative Impact on Business Growth		
Ranking	**Number of votes**	**Sector**
1	22	Difficulty finding and retaining quality employees
2	5	Supply chain disruptions
3	4	Economic conditions
4	2	Inflation
5	1	Material prices

Fig. 9. Similar to last year's results, Top 40 firms predominately listed "difficulty finding and retaining quality employees" as the single most challenging task they were facing.

that will eventually go away, but it can sustain you for a long time."

LABOR ISSUES PERSIST

Over time, infrastructure work could prove to be gravy for many design firms looking to grow. And, of course, what firm isn't? But obstacles to growth are ever-present and often changing. One that persists, though, is the challenge of maintaining a capable workforce. The difficulty of finding and retaining quality workers was again rated the top growth impediment this year, far outpacing other factors (**Fig. 9**).

And labor, generally, again surfaced as a concern. Almost without exception, firms said they were experiencing labor shortages in a period of high demand (**Fig. 10**). Most firms — even more than last year — said they added employees in the prior year (**Fig. 11**) and planned to

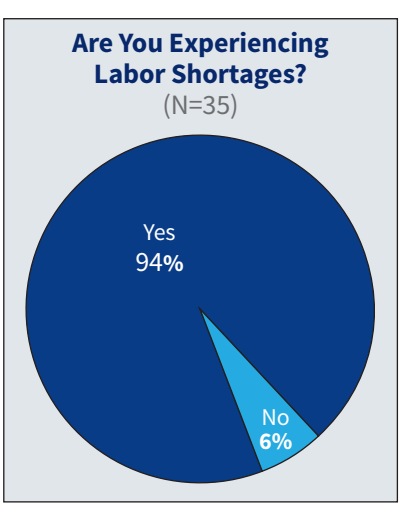

Fig. 10. As if the labor shortage couldn't get more prominent, the number of survey respondents experiencing staffing issues shot up again this year — from 70% in 2021 to 92% in 2022 to 94% in 2023.

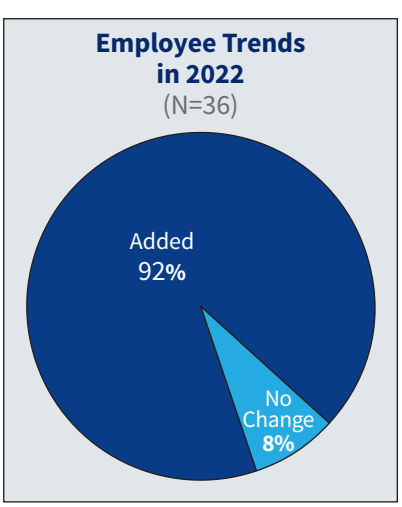

Fig. 11. The number of Top 40 adding headcount in 2022 increased slightly from the previous year (92% in 2022 compared to 81% in 2021). Unlike last year, no firms indicated they laid off employees.

ADJUSTABLE • NON-METALLIC • 2-HOUR FIRE RATING

Made in USA

IN/OUT™ BOX for Fans & Fixtures

EASY TO INSTALL... IN NEW CONSTRUCTION

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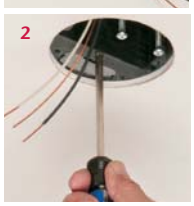
Arlington's **IN/OUT™** ***fan/fixture boxes*** adjust up to 1-1/2" to accommodate varying ceiling thicknesses, like single or double drywall. **FBA426** is Listed for fans up to 70 lbs; fixtures up to 100 lbs.

- Pre-set for 1/2" ceiling – depth adjustment screw positions the box flush with the ceiling *after it's in place*
- Complies with 2020 NEC, 314.20 for set back boxes
- (4) screws attach box securely to joist in new work
- **2-Hour Fire Rating**

Patented

20.0 cu in **FA426** for Fixtures *only* up to 50 lbs



1 Cutaway: Box set back in double drywall

2 Install ceiling. If necessary use depth adjustment screw to position box flush with ceiling.

Product info aifittings.com/landing/fba426

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ECONOMICAL SINGLE and TWO-GANG NON-METALLIC

Made in USA

VAPOR BOX for Devices

NAILS TO STUD IN NEW CONSTRUCTION

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Designed for devices, Arlington's *economical* single and two-gang **Vapor Boxes** offer easy nail-on installation in new construction.

These cost-saving boxes don't include gaskets, but when caulked around the NM cable during installation, they **meet the requirements of NEMA 0S-4.** And help meet International Energy Conservation Codes (IECC), and other codes *where required.*

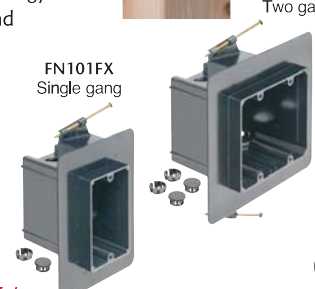
- Nails ship captive. Plugs and NM cable connectors supplied.

2-hour Fire Rating

Patented

FN102FX
Two gang

FN101FX
Single gang



Product info
aifittings.com/landing/fn101fx-fn102fx/

UL LISTED

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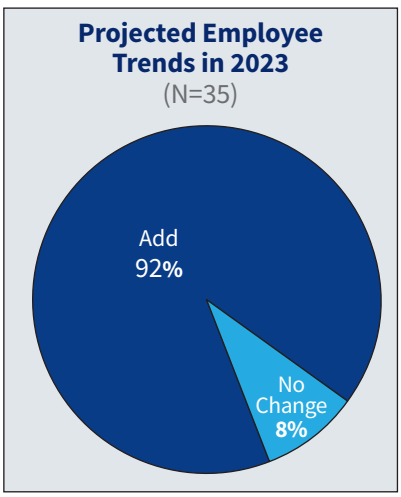


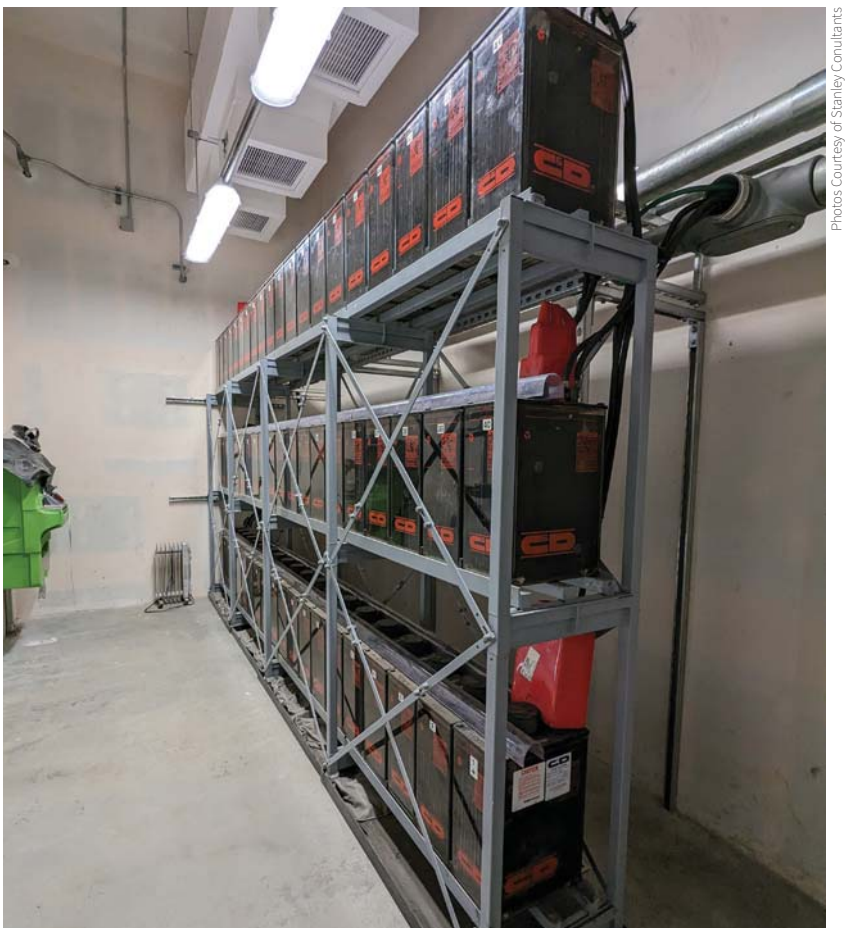
Fig. 12. Last year's survey reported a never-before-seen 100% of firms indicating they planned to add headcount. This year, that number dropped to 92%.

add to their workforce in 2023 (**Fig. 12**). For the third year running, firms say the toughest electrical design-related position to fill is project engineer (**Fig. 13**).

New York-based Syska Hennessy Group (No. 18) is banking on its growing involvement in projects that have significant cutting-edge technology components to act as a lure for engineers who have many employment options, says President and CEO Cyrus Izzo. The firm continues to bring on motivated college graduates every year and aims to keep their fires burning with a dedicated engineer development program — and through a startup-investment initiative that positions the company to deliver direct designer exposure to emerging design technologies.

"Trying to source strong talent to design these highly complex electrical systems we're seeing today is a challenge," he says. "Grads coming out of these electrical engineering programs have lots of options beyond what we do in the building trades industries, so we need to demonstrate we're not a stodgy engineering firm."

Newly minted talent can only go so far in supplying firms' personnel needs, however. Firms engaging in a growing array of projects heavy on electrical emphasize the need for engineers who can build on established skill sets and take leadership roles in groups that are having to stretch their capabilities.



Photos Courtesy of Stanley Conultants

This battery room backs up DC power for internal plant critical infrastructure in case of loss of power from the plant's generation and external grid. Completed by Stanley Consultants, this job was part of the Colorado Springs Utilities Modernization Project.

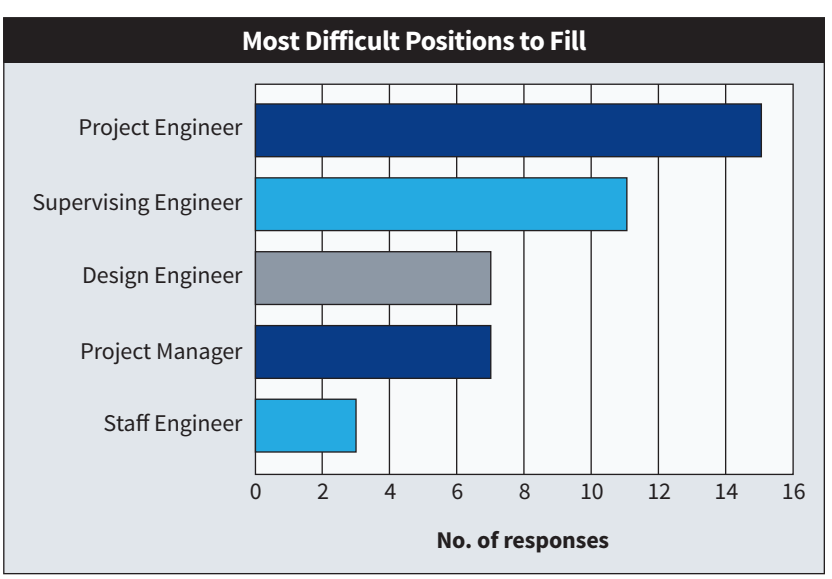


Fig. 13. For the third year in a row, "project engineer" topped the list as "most difficult job title to fill" for Top 40 firms followed closely by "supervising engineer."

NON-METALLIC NM3100 SERIES • PRE-INSTALLED STRUT CLIP

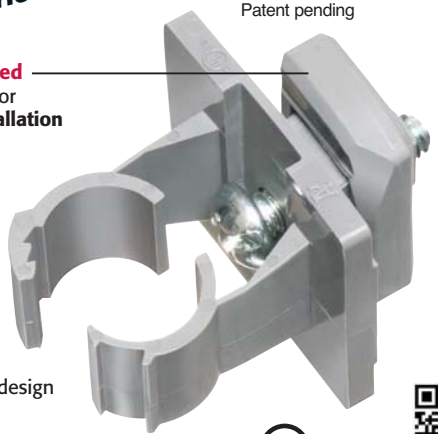
Made in USA

QUICKLATCH™

EASIER TO USE THAN A PIPE HANGER

NEW NM3100 series

Patent pending



Pre-installed strut clip for **faster installation on strut**

Stainless steel screw

UV rated for use outdoors

Extra-duty one-piece design

Listed for environmental air handling spaces

c UL us

MOUNT. PRESS PIPE into QUICKLATCH. DONE!

SAVES 20 SECONDS per Installation!

...about 33¢ each at $60/hr labor!

1/2" NM3105 for RIGID, IMC, PVC – **NM3100** for EMT
3/4" NM3115 for RIGID, IMC, PVC – **NM3110** for EMT
1" NM3125 for RIGID, IMC, PVC – **NM3120** for EMT

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Info aifittings.com/landing/quicklatch_series

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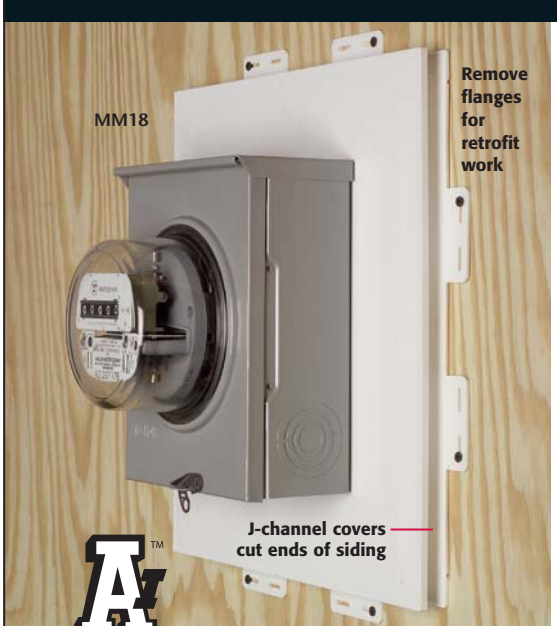
ONE-PIECE • NON-METALLIC

Made in USA

METER MOUNTING BASE

INSTALLS ON SIDING – AND OTHER SURFACES



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Arlington's one-piece, non-metallic Mounting Bases provide a smooth, flat mounting surface for most electric meters, *including the largest sizes* – as well as a variety of other products such as timers, disconnects, inlet boxes and more.

UV rated, paintable plastic for long outdoor life.

Available with squared-off corners, they're *gangable* so you can create the mounting base you need for the product you're installing.

NEW 5x7

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NEW

MM7 **5" X 7"**	MM18 15-7/8" X 17-5/8"
MM10 7" X 10"	MM23 17-5/8" X 23"

MM7 info aifittings.com/landing/mm7
Other aifittings.com/landing/meter-mounting-bases

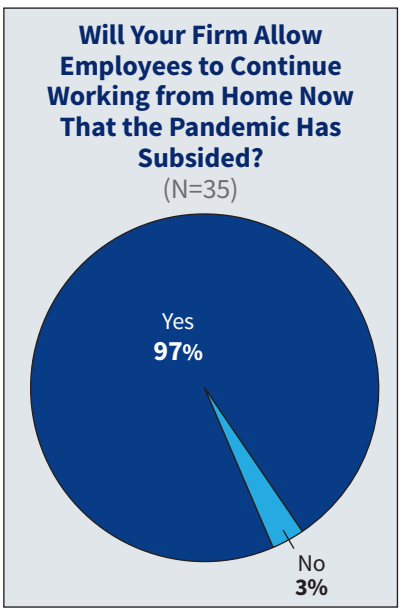

Fig. 14. Last year, an unprecedented 100% of survey respondents indicated that their firms will allow employees who used to work in the office to continue working from home in a part-time or full-time capacity following the pandemic. This year, that number dropped slightly to 97%.

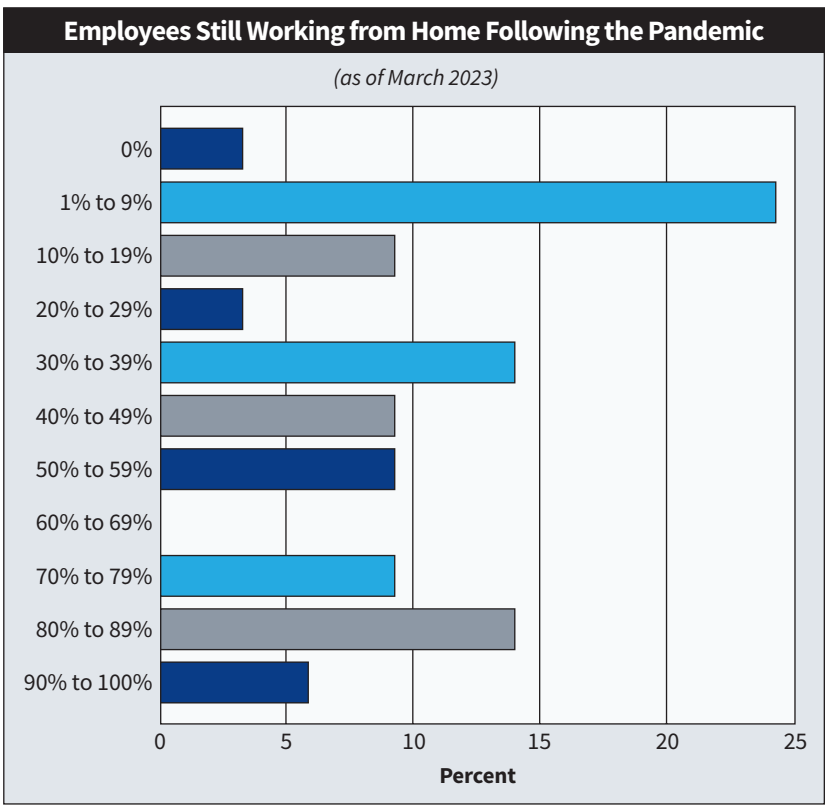

Fig. 15. Three years ago at this time, more than two-thirds (69%) of Top 40 firms were allowing at least 90% of their labor force to work from home (who weren't doing so previously) due to the pandemic. That number dropped to 14% last year and then to 6% this year, indicating a shift toward more in-person work environments.

"The big one for us is the experienced engineer," says Goss, whose top CDM Smith staffing challenge is design engineer. "It seems we can identify and attract new engineers, but it's not always the solution to go that route. Those experienced people are key — the mid-level types who can bolster the team."

Smith Seckman Reid is seeking and now finding more senior-level MEP design talent "who've been scarce," Valentini says. At the same time, the company continues to prioritize its intern recruiting program, convinced that it's a reliable way to identify and secure fresh talent. "We have 13 lined up for this summer to give them a taste of what consulting engineering is like and get them to full-time status later. We treat them just like new college grad hires."

One way some firms are navigating hiring issues is to make remote, non-office-based work, more available. A trend that started during the depths of the COVID-19 pandemic, work-from-home arrangements have become normalized, giving employers a tool to possibly make life easier for employees without sacrificing work quality. Almost every firm says they're letting formerly office-based workers work from home full- or part-time post-pandemic (**Fig. 14**). Just shy of 40% of Top 40 firms say they're still permitting at least half of employees who switched to remote work during the pandemic to continue to do so (**Fig. 15**). That number, though, has been falling. Slightly more than half of last year's Top 40 said that was the case; the year before it was 100%.

Design firms are taking a mixed view of remote work. While many say it's a proven win-win for them and employees, others are stepping up efforts to get associates back to the office in some capacity.

Like many other firms, Burns Engineering is adopting a hybrid model that blends remote and on-site work. Three days in the office and two at-home is now the default, Walton says — an arrangement that recognizes the value of both but tilts toward a return to business as usual.

"Remote work has given us more flexibility and options," he says, "but we see value in having that in-person collaborative and coordination part of the hybrid approach."

Ultimately, he says, there's a trade-off. Office-based work, he says, remains critically important for getting younger staff trained and mentored, but the ability to offer technology-enabled remote work probably does expand the hiring and recruitment lens.

Syska Hennessy is taking a less nuanced view. Izzo is adamant that in-office, face-to-face work is preferable (if not essential). Staff have been mostly back in office for a year and a half; now the standard is four 10-hour days in office with a four-hour day Friday that can be remote.

"There's room for some flexibility, but our clients expect us to be in the office and on job sites, and the construction community we work with requires that

STEEL BOX WITH BRASS COVER

LISTED SINGLE GANG FLOOR BOX KITS

CONVENIENT, FLUSH-TO-THE-FLOOR RECEPTACLE INSTALLATION

FLB5331NL
Single gang
steel box kit
w nickel-plated brass cover

FLB5331MB
Single gang Kit
w brass cover

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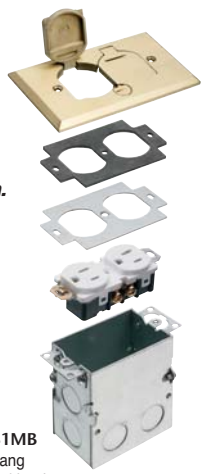
Arlington's **STEEL FLOOR BOX KITS** give installers a low cost, *convenient* way to install a receptacle *in a new or existing floor*.

Our Listed Single Gang Steel Floor Boxes deliver easy, flush-to-the-floor installation.

- Brass covers hide miscut flooring; gaskets prevent water intrusion; flip lids protect the box when it's not in use.
- Single gang brass and nickel-plated **Brass Covers** fit our boxes *and other manufacturers' single gang boxes.*

Covers also sold separately.



FLB5331MB
Single gang
steel box kit w brass cover

for NEW or existing floors

c UL us

Product info aifittings.com/landing/flb5331-flb5551-kits

IN BOX® RECESSED COVER KITS

INSTALLS INSIDE 4.5" CONCRETE BOXES

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Arlington's **IN BOX® Recessed Cover Kits** are the neat way to install a receptacle in an installed 4.5" concrete floor box, *including our FLBC4500 or FLBC4502 boxes.*

IN BOX covers install fast, *inside the can* reducing trip hazards caused by plugs sticking out of the box. They look great. And, you can have power and low voltage in the *same* box.

Assembled IN BOX, comes with matching in-use slotted cover and cover blank for unused boxes in **brass** or **nickel-plated brass**

...and **plastic** in FIVE colors.

Product info aifittings.com/landing/inbox-cover-kits/

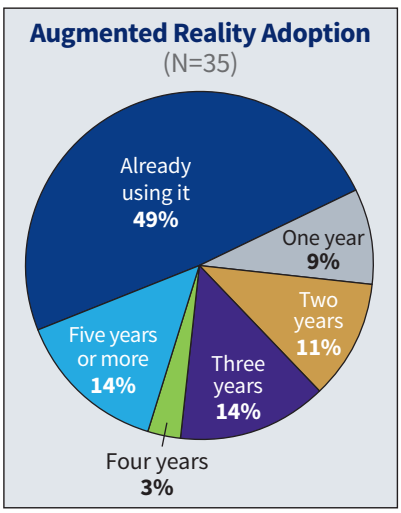


Fig. 16. On the topic of AR adoption, Top 40 firms seem to be consistent with 2022 survey results. Last year, 47% of Top 40 firms said they were already using AR compared to 49% this year. However, the number of respondents indicating it would be five years or more before they adopted the technology dropped six percentage points this year.

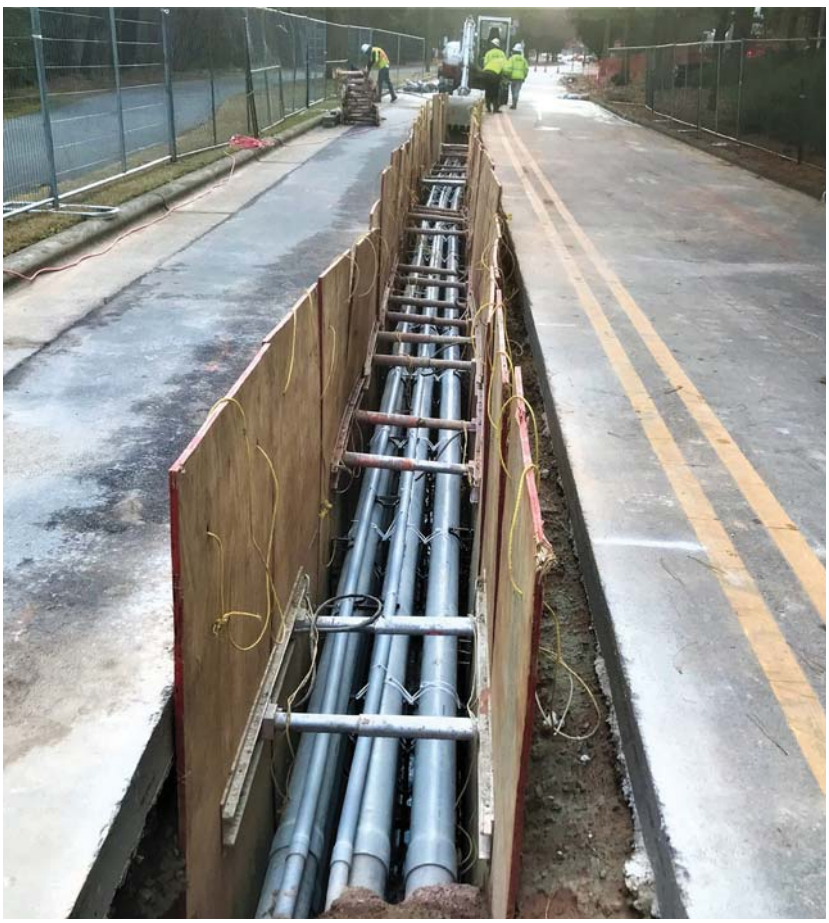
field time," he says. "So, we don't see how we can be successful being on a Zoom camera or a Teams call."

TECHNOLOGY TO THE RESCUE

Yet technology in all its forms is increasingly enabling design firms to execute their skills and knowledge in the heavily collaborative endeavor of construction. Technology-aided communication, design, and engineering is the wave of a future in which productivity, exacting work, and broad knowledge will be at a premium.

One of the many emerging technologies that will be at firms' disposal is augmented reality (AR) and virtual reality (VR), tools adaptable to either enhancing or fully simulating project designs. Almost half of respondents say their firms are now using both AR and VR in some fashion in their work, a number that has been rising. And with both, collaboration with clients is the undisputed top application (**Fig. 16, 17, 18** on page 34, and **19** on page 34).

More specifically, about a dozen firms noted how they're using it in electrical



Photos Courtesy of RMF Engineering

The power distribution system for the main campus at NC State consists of 17 distribution feeders to serve approximately 100 buildings and two express feeders to serve central energy plants. The project, completed by RMF Engineering, included approximately 30,000 linear feet of new underground electrical duct bank, 55 new electrical switches, and 100 building transitions from the existing system to the new system.

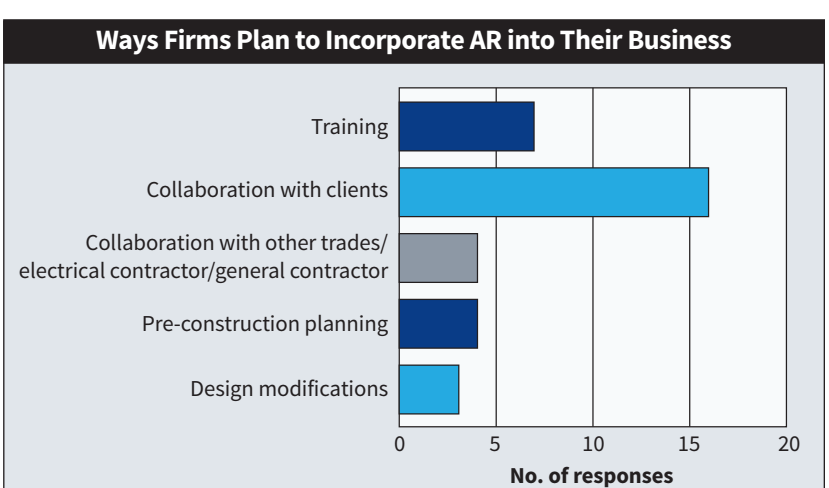
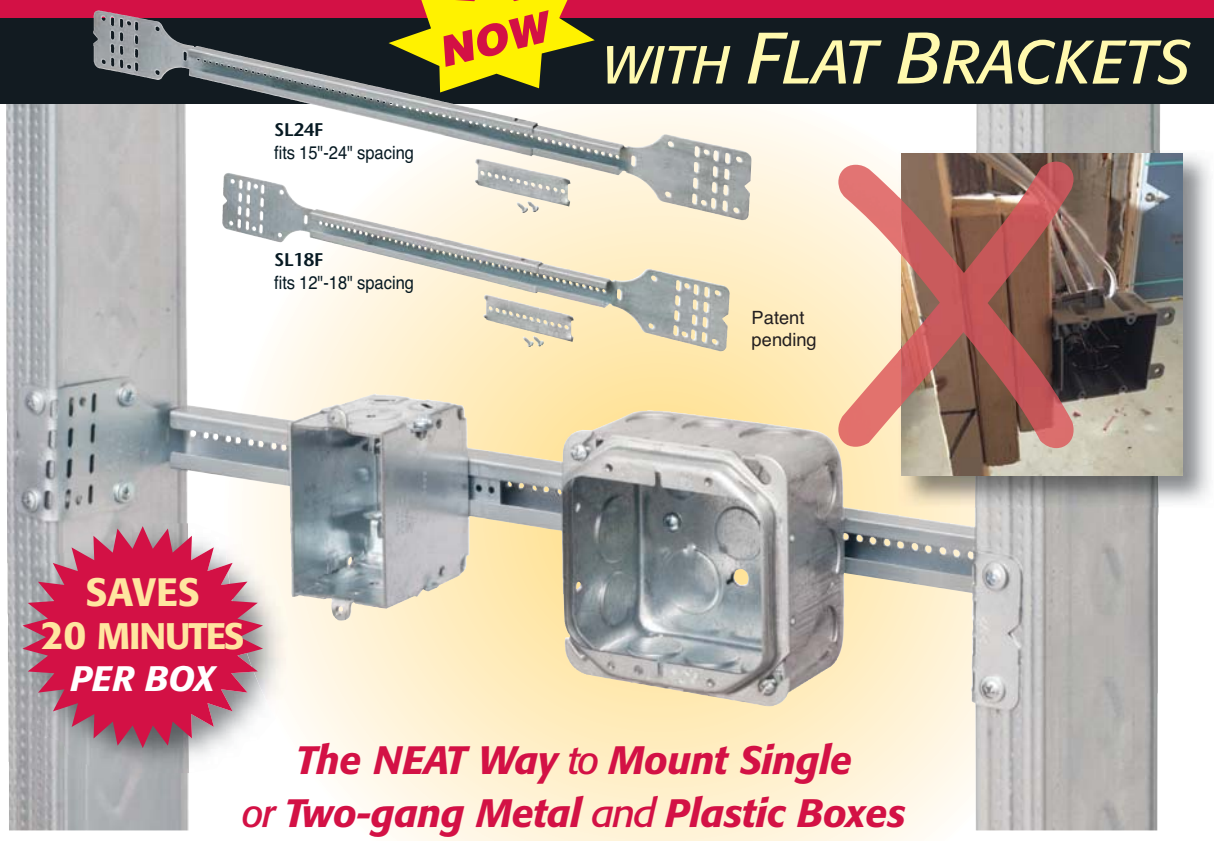


Fig. 17. As has been the case for the past several years, Top 40 firms already using this technology overwhelmingly indicated they plan to use AR for "collaboration with their own clients."

LISTED • LOOKS GREAT • SAVES TIME

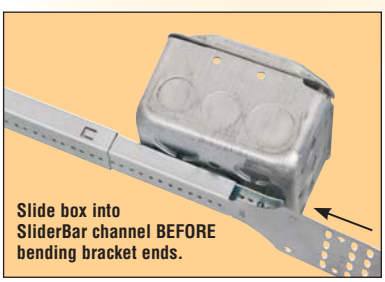
ADJUSTABLE SLIDERBAR™

NOW WITH FLAT BRACKETS



The NEAT Way to Mount Single or Two-gang Metal and Plastic Boxes


Attach mounting bracket to box.


Slide box into SliderBar channel BEFORE bending bracket ends.


Bend SliderBar bracket ends 90°. Bend ends again along guides to desired wall board thickness.

Here's the easy way to mount single *or two-gang* boxes between wood *or metal studs* with non-standard stud cavities.

Arlington's steel **SliderBar**™ looks great and ***saves about 20 minutes per box*** over cutting, nailing and placing extra 2x4s! *It's available in two styles – with pre-bent brackets – or FLAT BRACKET ends. And in two adjustable sizes for studs spaced 12 to 18 inches – or 15 to 24 inches apart.*

The extra convenient SliderBar with FLAT brackets comes with a steel mounting bracket for installing almost any metal box, and our plastic SLB101 and SLB102 boxes, on the bar anywhere in the stud cavity.

Use the SL18BKT mounting bracket.to add another metal box on FLAT SliderBar.

Metal boxes mounted on SliderBar are rated for non-metallic and MC, AC and Flexible Metal Clad cable

- **Guides on bracket ends** assure proper positioning on studs
- **Interlocking tab stop** prevents accidental disassembly
- **Pre-punched pilot holes** on BOTH sides of SliderBar allow for easy attachment of boxes

c UL us

SL18F FLAT SLIDERBAR KIT Adjusts to fit between studs, 12" to 18" o.c.

SL24F FLAT SLIDERBAR KIT Adjusts to fit between studs, 15" to 24" o.c.

SL18F, SL24F include flat SliderBar, steel mounting bracket, (2) #8 x 1/2" screws

SL18BKT Steel Mounting Bracket w mounting screws

SLB101 PLASTIC BOX Single gang • pre-formed screw holes

SLB102 PLASTIC BOX Two gang • pre-formed screw holes

Arlington™

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www.aifittings.com Scranton, PA 18517 **800/233-4717**

Product info aifittings.com/landing/sliderbar

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Photo courtesy of P2S

P2S provided MEPT engineering services for the establishment of Education First Academy's Pasadena Campus in California.

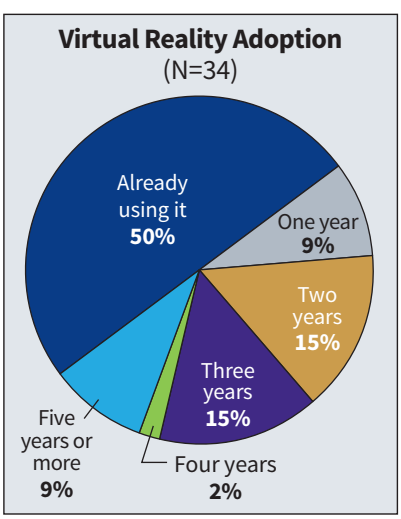


Fig. 18. Virtual reality adoption stayed about the same as last year for Top 40 firms — rising from 49% to 50% for firms saying they're already using it. However, the number of firms indicating it would be five years or more before they considered implementing the technology dropped drastically from 20% last year to 9% this year.

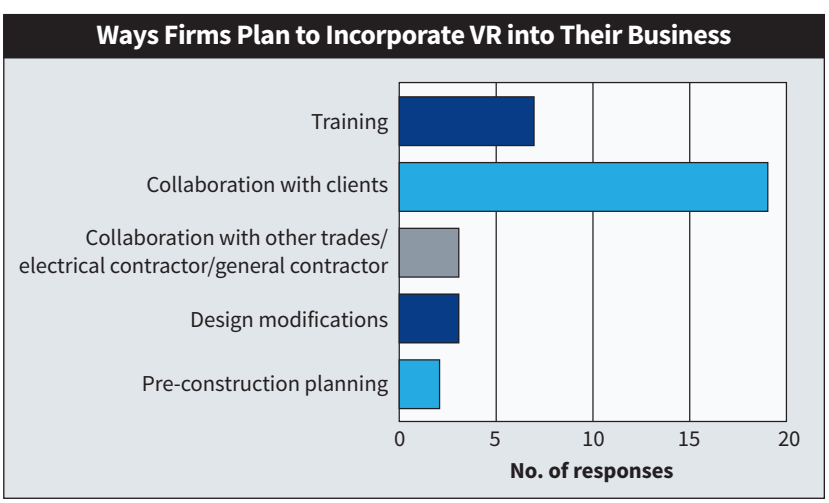


Fig. 19. As is the case with AR, the results from this year mirrored last year's responses. Top 40 firms that are already using this technology overwhelmingly indicated they plan to use VR for collaboration with their own clients.

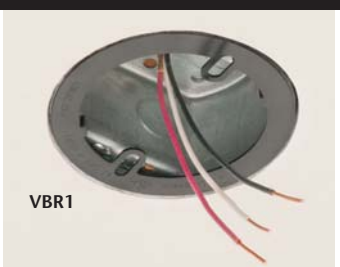
design. Among AR uses are "electrical room space planning"; "electrical design team collaboration"; "in BIM models for clash detection"; "electrical product development and site placement"; and "walk-through models to assist in project development." With VR, uses noted were: "walk through of facilities with complex electrical and mechanical systems"; "conduit and cable tray layout"; "training operators"; "visualization of designs with clients and trade partners"; "simulation for process automation"; and "mapping powerhouse interiors."

For IMEG, Leavitt says, AR/VR is proving a handy (but sparingly used) tool to bring select clients deeper into the design process. Getting informed client involvement and feedback those tools enable (earlier on) can help limit costly surprises later, he explains. For now, though, IMEG, echoing other firms' comments, is "leveraging it where it makes sense, as a complementary tool."

ARLINGTON'S ECONOMICAL VAPOR BARRIER COVERS Made in USA

PREVENT AIR INFILTRATION

AROUND STEEL AND PLASTIC BOXES • *WITHOUT A GASKET*



Round or Octagonal ceiling boxes

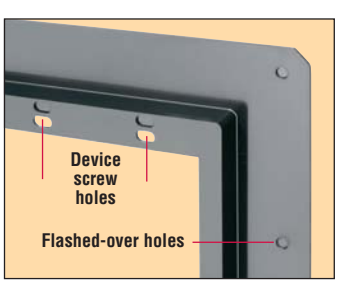
Single and Multi gang boxes

For help Obtaining ENERGY STAR rating

Arlington's vapor barrier covers prevent air infiltration around single, *and* ***NOW two-*** *and* ***three-gang outlet boxes*** *and* ***round and octagonal ceiling boxes,*** **without the need for a gasket.**

Installation is easy. Two screws hold the vapor barrier cover *temporarily* in place during the installation of 1/2" or 5/8" drywall, through the device screw holes or the flashed-over holes in the flange. After the drywall's installed remove the screws, *if using the device screw holes,* and install the device.

Designed for new work, VB1 and the **new VB2**, **VB3** and the round **VBR1** install on most plastic or steel boxes.



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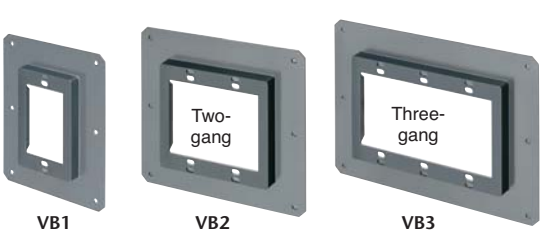

VB1 VB2 VB3

for single-gang round or octagonal boxes

www.aifittings.com Scranton, PA 18517 **800/233-4717**

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Product Info aifittings.com/landing/vb1

Photo courtesy of ZGF Architects

Stantec provided electrical, technology, lighting, and acoustical consulting for the new 310,000-square-foot expansion at Seattle Children's Hospital, which is phase two of a three-building expansion.

Second to client collaboration, firms cited training as a way they're using AR/VR, and the number of mentions doubled. At EPS, Cross says, AR/VR will be a central component of a new training center its parent company is opening in Nashville, Tenn. to aid EPS and sister companies. It will deliver the type of "immersive" training experience employees

© Edward Caruso Photography

Designed by JB&B, electrical distribution infrastructure to support Memorial Sloan Kettering Cancer Center's new intraoperative MRI consisted of an uninterruptible power supply serving the magnet to allow for full system functionality upon a loss-of-utility-power interruption as the room transitions to an emergency power source.

NON-METALLIC • VENTED FOR EASIER STACKABILITY

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CONCRETE PIPE SLEEVE

THE EASY, ECONOMICAL WAY TO SLEEVE THROUGH CONCRETE POURS!

CPS40
Pipe Sleeve
for 4" hole

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Arlington's **Concrete Pipe Sleeves** are the economical way to sleeve through concrete pours in tilt-up construction WALLS – and FLOORS *allowing cable and conduit to run easily from one floor to the next.*

No costly core drilling – No cutting holes in the form. Plus, you can position the hole prior to pouring the concrete.

- Attaches to form with nails or screws
- Stackable up to 23" h for extra deep pours
- Vents keep wet pipe sleeves from sticking together
- Multiple hole sizes: 1-1/2" • 2" • 3" • 4" • 5" • 6"

CPS40

Nail sleeve to form.

After concrete sets, cut sleeve flush with surface.

Insert conduit into sleeve.

Arlington® 800/233-4717 • www.aifittings.com

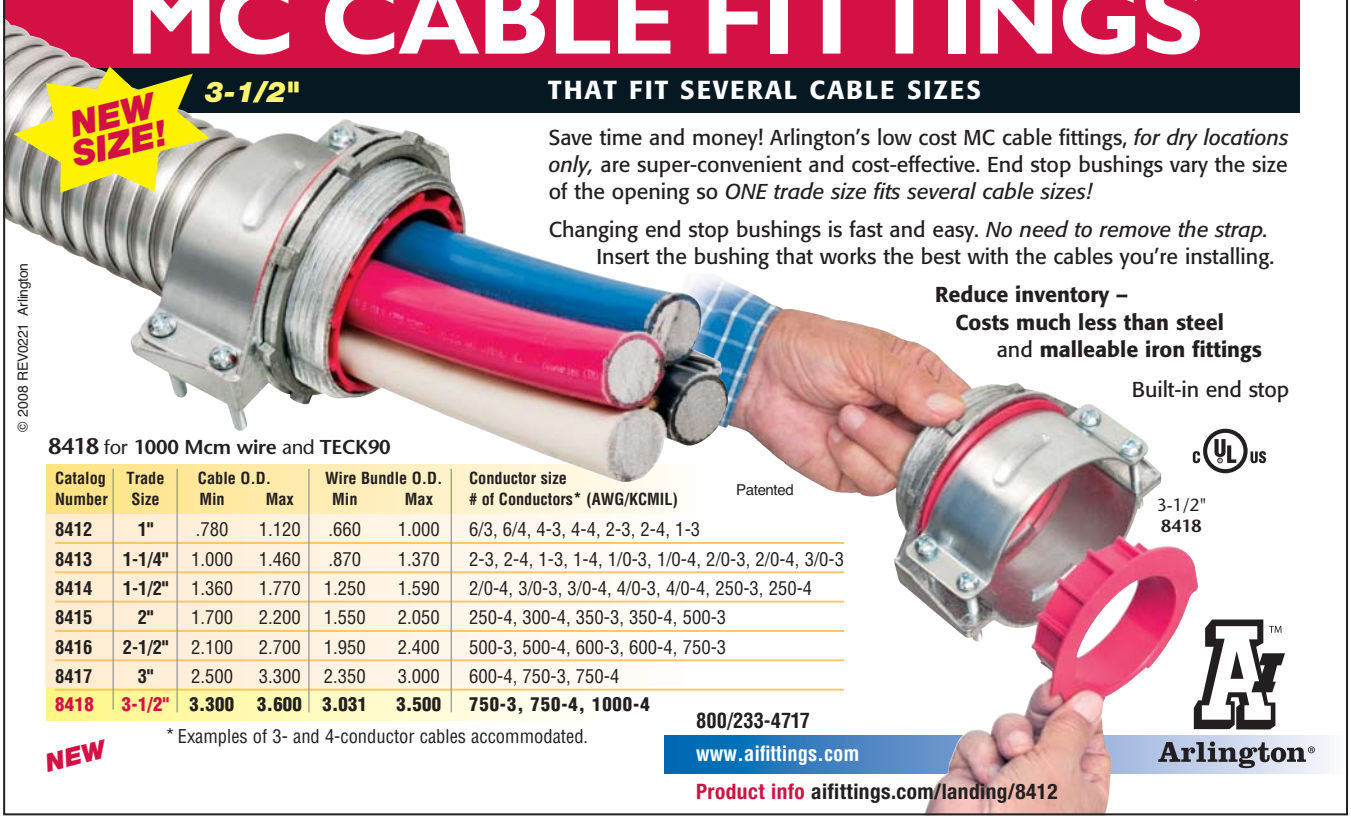
Product info aifittings.com/landing/concrete-pipe-sleeve

LOW COST • ZINC

Made in USA

MC CABLE FITTINGS

NEW SIZE! **3-1/2"** THAT FIT SEVERAL CABLE SIZES



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Save time and money! Arlington's low cost MC cable fittings, *for dry locations only,* are super-convenient and cost-effective. End stop bushings vary the size of the opening so *ONE trade size fits several cable sizes!*

Changing end stop bushings is fast and easy. *No need to remove the strap.* Insert the bushing that works the best with the cables you're installing.

Reduce inventory –
Costs much less than steel and malleable iron fittings

Built-in end stop

c UL us

Patented

3-1/2"
8418

8418 for **1000 Mcm wire** and **TECK90**

Catalog Number	Trade Size	Cable O.D. Min	Cable O.D. Max	Wire Bundle O.D. Min	Wire Bundle O.D. Max	Conductor size # of Conductors* (AWG/KCMIL)
8412	1"	.780	1.120	.660	1.000	6/3, 6/4, 4-3, 4-4, 2-3, 2-4, 1-3
8413	1-1/4"	1.000	1.460	.870	1.370	2-3, 2-4, 1-3, 1-4, 1/0-3, 1/0-4, 2/0-3, 2/0-4, 3/0-3
8414	1-1/2"	1.360	1.770	1.250	1.590	2/0-4, 3/0-3, 3/0-4, 4/0-3, 4/0-4, 250-3, 250-4
8415	2"	1.700	2.200	1.550	2.050	250-4, 300-4, 350-3, 350-4, 500-3
8416	2-1/2"	2.100	2.700	1.950	2.400	500-3, 500-4, 600-3, 600-4, 750-3
8417	3"	2.500	3.300	2.350	3.000	600-4, 750-3, 750-4
8418	**3-1/2"**	**3.300**	**3.600**	**3.031**	**3.500**	**750-3, 750-4, 1000-4**

NEW

* Examples of 3- and 4-conductor cables accommodated.

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Product info aifittings.com/landing/8412

Photo courtesy of Burns & McDonnell

Workers set one of 122 battery containers at the Moss Landing battery energy storage site. Each container is home to 924 battery modules. The containers were engineered, pre-fabricated, and shipped from Pittsburgh, Kan. to Moss Landing, Calif., where they were set into place by Burns & McDonnell's self-perform construction team.

need to learn elements of design and construction and to work safely, he says.

TRAINING FOR THE FUTURE

Training, more broadly, remains a top focus of Top 40 firms. Given persistent hiring challenges, more complex design demands, and a fast-changing and an evolving electrical design world, the ability to effectively deliver pertinent and essential training is paramount. Training areas of top concern for firms may reflect some of the market pressures they're feeling. The top areas firms say employees need the most training support in, firmly headed by power systems analysis, align with trending issues design firms encounter (**Fig. 20**).

Wollum says electrical safety and aspects of smart buildings are key areas of training needed at Henderson Engineers. Designers must be familiar with incident energy calculations and updates to the National Electrical Code that reflect rapid changes in how power is generated and distributed. With buildings, clients need electrical designers who fully grasp the complexities of management and automation systems that consistently overpromise and underperform.

"That's a lost discipline," he says. "But it's a critical piece of making buildings function that is not well defined and that

Areas in Which Employees Need the Most Training

Ranking	Number of votes	Sector
1	20	Power system analysis
2 (tie)	17	National Electrical Code
2 (tie)	17	Electrical design software
4	16	Building management/building automation systems
5	5	Selective coordination
6	4	Incident energy calculations
7	3	LED/intelligent lighting
8	2	Bonding & grounding

Fig. 20. Again this year, Top 40 firms report needing training in multiple areas, but especially related to power system analysis, the NEC, and electrical design software.

STAINLESS STEEL • POP UP COVER

FLOOR BOX KITS

EASY RECEPTACLE INSTALLATION • *NO DISASSEMBLY!*

Cover closes flush

FLBT7200BL
Black stainless steel cover

FLBT7200SS
Stainless steel cover

Arlington's **Pop-up COVER/BOX KITS** provide options for installing a device in a floor – or a countertop!

The kits include a 20A receptacle OR you can install one of your own. It's *easy.*

The device installs from the front. There's no need to dismantle the hinge mechanism. Just remove the white cover plate, install the receptacle and replace the cover plate.

c UL us
Listed as floor box

Gasketed stainless steel or black stainless trapdoor covers close flush with the surface, preventing damage to the device and minimizing trip hazards in a floor installation.

- Easy **'No Glue'** installation – the spring steel clip holds box securely against the surface when screws are tightened
- Fits surfaces up to 1-1/2" thick
- Uses standard rectangular receptacle, and GFCI, and GFCI/combination receptacles

Patent pending

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Product Info aifittings.com/landing/flbt7200-floorbox-kits

Lucas Blair Simpson © SOM

Spanning more than 1,000,000 square feet, the new $1.5-billion single terminal at Kansas City International Airport (KCI) is the largest infrastructure project in its region's history. As lead engineer on the project, Henderson Engineers designed an all-electric power system for airport operations.

clients are routinely frustrated with. So, we're working to create that as its own discipline here."

With demand for smart, energy-efficient, and fully electric buildings growing, Henderson may be aiming for a niche — something many Top 40 firms in a crowded and demanding marketplace appear to covet. Looking down the road, most firms picked gaining a competitive advantage, specifically via technology, from a short list of possible top long-term company concerns (**Fig. 21**). Further down in mentions were factors related to personnel management magnified during the pandemic.

Both are related, Wollum says, in that AR/VR, BIM and similar tools improve productivity and help firms navigate likely challenges in finding sufficient design talent.

Factors Having the Greatest Long-Term Impact as a Result of the Pandemic

Ranking	Number of votes	Sector
1	28	Use technology to gain a competitive advantage, such as increased use of artificial intelligence, augmented reality and virtual reality tools
2	23	Allow more employees to work from home part- or full-time
3 (tie)	14	Conduct more meetings virtually that were previously held in person
3 (tie)	14	Revise HR policies to include more sick leave, additional mental health resources, and wellness programs
5	7	Put an increased focus on employee health and safety
6	5	Decrease typical employees' travel schedules

Fig. 21. Several factors were identified by Top 40 firms as having the greatest long-term impact on their firms going forward as a result of the pandemic. Allowing more employees to work from home (the top response last year) was surpassed by "using technology to gain a competitive advantage."

ECONOMICAL • INTERLOCKING

GANGABLE FLOOR BOX

FOR NEW CONCRETE FLOORS

NEW COVERS!

(1) **FLBC8530BL**
Black plastic
cover/frame kit

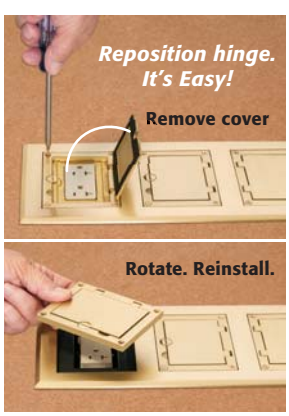
(3) **FLBC8500**
boxes

HERE'S HOW IT WORKS...

Connections on sides lock single gang FLBC8500 boxes securely together

Lock two boxes together for a two-gang box. Add another for three-gang!

Covers open in Both Directions



PLASTIC Listed Cover/frame kits
NOW IN PLASTIC, FIVE Colors!

Build a two- or three-gang concrete floor box by simply locking *single gang* boxes together!

Then buy the UL LISTED single, two- or three-gang cover/frame kit, *with devices included*, in **PLASTIC, FIVE COLORS** – ***or in economical diecast zinc with a brass or nickel finish***. *Fast, easy installation.*

Cover installs with hinge on either side.

UL LISTED

Made in USA

Plastic Cover/frame Kit

Single gang
FLBC8510BR Brown
FLBC8510BL Black
FLBC8510GY Gray
FLBC8510CA Caramel
FLBC8510LA Lt Almond

Two-gang
FLBC8520BR Brown
FLBC8520BL Black
FLBC8520GY Gray
FLBC8520CA Caramel
FLBC8520LA Lt Almond

Three-gang
FLBC8530BR Brown
FLBC8530BL Black
FLBC8530GY Gray
FLBC8530CA Caramel
FLBC8530LA Lt Almond

FLBC8510BR

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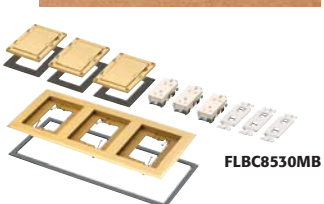

Metal Cover/frame Kit

Brass finish
Single gang **FLBC8510MB**
Two-gang **FLBC8520MB**
Three-gang **FLBC8530MB**

Nickel finish
Single gang **FLBC8510NL**
Two-gang **FLBC8520NL**
Three-gang **FLBC8530NL**

www.aifittings.com Scranton, PA 18517 **800/233-4717** Patented

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Product Info aifittings.com/landing/gangable-box-kits/

Photo courtesy of IMEG

IMEG worked on this 47,000-square-foot Palmer College of Chiropractic's new Building 4 in Port Orange, Fla., which houses high-tech classrooms, technique labs, and virtual- and augmented-reality tools.

Factors Having the Greatest Short-Term Impact from the Pandemic		
Ranking	**Number of votes**	**Sector**
1	30	Supply chain issues (delays in equipment or material shortages)
2	23	Delayed projects
3	12	Canceled projects
4	3	Failure to meet budget due to decreased revenue
5	2	Reduce company benefits, such as 401K match, bonuses, annual salary increases
6	1	Lost clients

Fig. 22. Although "delayed projects" still ranked high on the list, "supply chain issues" took the top spot as having the greatest short-term impact on Top 40 firms — increasing from 20 votes to 30 votes.

"Technologies like generative design and artificial intelligence, maybe more than AR/VR, are going to push electrical engineering forward," he says. "Demand for design professionals is growing, but fewer may be available — so technology can help bridge that gap."

Along with long-term strategic concerns, design firms dealt with a full plate of short-term tactical issues that took root in 2022 and continue into 2023. Supply chain snarls and delayed and cancelled projects were the top vote-getters from a list of factors possibly exacting short-term pain on design firms last year (**Fig. 22**).

Equipment delays, materials shortages, and project delays presented significant design challenges last year at Burns Engineering, and there's no indication they're in the rear-view mirror, Walton says.

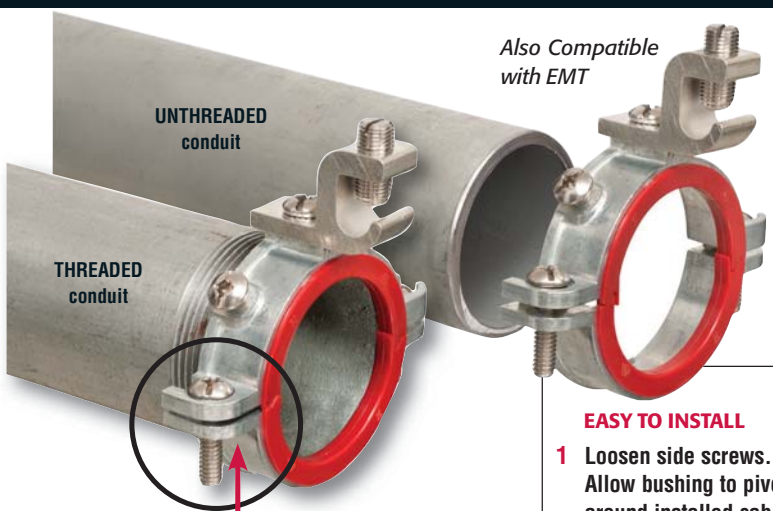
Photo courtesy of Syska Hennessy Group

Syska Hennessy Group installed a new medium-voltage transformer in this vault area at an airport.

SPLIT GROUNDING BUSHINGS

for THREADED and UNTHREADED RIGID and IMC

EC&M Product of the Year
2023 Category Winner

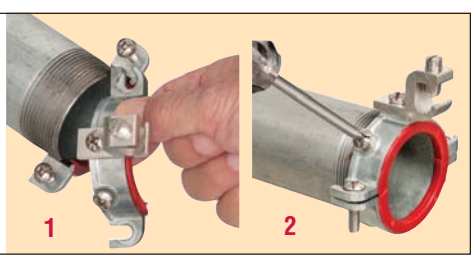


Get convenience and time-savings with Arlington's 550 series **SPLIT grounding bushings**. The split allows the addition of a bushing AFTER conductors are installed in threaded or unthreaded Rigid/IMC conduit. Great for tight spaces!

- In 1/2" to 4" trade sizes – Ships Assembled
- Compatible with EMT, 2-1/2" to 4" trade sizes, and threaded electrical fittings

EASY TO INSTALL

1. Loosen side screws. Allow bushing to pivot around installed cables
2. Tighten set screw to seat bushing on conduit



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aifittings.com/landing/split-grounding-bushings

NON-METALLIC

Made in USA

FIXTURE BOXES for Siding

EASY INSTALLATION

Arlington's **8141F** and **8081F** boxes deliver the fastest, easiest way to install light fixtures and receptacles on siding. *Good looks. Smooth vertical mounting!*

- Easy to install one or two-piece styles for any siding type
- NM cable connector included
- UV rated for long outdoor use
- Textured, paintable finish

ONE piece 8141F Fixture Box	VS	TWO piece 8081F Electrical Box
No extra cover to lose or store		Separate cover and box
For light fixtures		For light fixtures, standard receptacles
Costs less than 8081F		

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aifittings.com/catalog/siding-mounting-blocks/siding-mounting-block/8141F

Photo courtesy of CDM Smith

Emergency generators rated at 13.2kV that became operational in June 2022 at the Mark B. Whitaker Water Treatment Plant in Knoxville, Tenn. were the result of engineering and design work by Boston-based CDM Smith, a design partner in the facility's generator/electrical building upgrade project.

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"Supply chain issues are continuing. For major equipment like switchgear and transformers, lead times have gone from 16 to 24 weeks to a year," he says. "We've had to design around this and communicate more closely with clients about delays, lead times, and the cost impact of inflation on major components of projects."

For electrical design firms, 2022 will likely go down as a year that produced mixed emotions; revenue growth was off the charts, but the work was frantic and full of novel challenges. That may be a sign of things to come. The future looks bright, but speed bumps from economic uncertainty and disruption could emerge in the short-term, and growing demand for services over the longer term will pressure firms to supply the resources equal to the challenge.

"The market is very robust, but the industry is short on electrical designers while the needs will continue to accelerate," says Salas O'Brien's Anderson. "My goal is to marshal as much great electrical engineering talent as possible." EC&M

Tom Zind is an independent analyst and freelance writer based in Lees Summit, Mo. He can be reached at tomzind@att.net.

SNAP²IT® CONNECTORS

EASIEST CABLE INSERTION • NO TOOLS • SECURE HOLD

Fully assembled, **SNAP²IT®** fittings **handle the widest variety of MC cable *AND THE NEW MC-PCS cables.***

Compared to fittings with a locknut and screw, you can't beat these snap in connectors for time-savings!

- **Fits widest range and variety of MC cable** 14/2 to 3/3 AC, MC, HCF, MC continuous corrugated aluminum cable and MCI-A cables (steel and aluminum)...*including the new MC-PCS cable that combines power and low voltage in the same MC cable*

  ANY Snap2It Connectors LISTED for MC cable are also LISTED for MC-PCS cable! *These products offer the greatest time-savings.*
- **Fast, secure snap-on installation**
- **Easy to remove, reusable connector**
  From cable Loosen screw on top. Remove connector from cable.
  From box Slip screwdriver under notch in Snap-Tite® ring. Twist. Remove connector.

CATALOG NUMBER	DESCRIPTION Snap2It® connectors	CABLE OUTSIDE DIA (OD)
4010AST	Snap in, 1/2" KO w insulated throat	.405 to .610
5010AST	Snap in, 1/2" KO w insulated throat	.580 to .780
505010AST	Duplex Snap in, 3/4" KO w insulated throat	(2) .590 to .820
4110ST	Snap in, 1/2" KO	.525 to .705
414110ST	Duplex Snap in, 1/2" KO	(2) .525 to .640
NEW! **4141107ST**	Duplex Snap in, 3/4" KO	(2) .525 to .690

Easy to Snap into Box!

Arlington®

Patented. Other patents pending.

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Product info aifittings.com/landing/snap2it-mc-cable-connectors

B4LLS/iStock/Getty Images Plus

How to Get the Best Design When Integrating Terminal Blocks

Best practices for optimizing electrical cabinet design

By Vincent Menager, TE Connectivity

It can be easy to take the humble terminal block for granted. Like the steel girder on a bridge, terminal blocks provide necessary structure and stability within the electrical panel. But once they're in place, it's easy to forget they're there. You drive over the bridge every day, but you don't think much about the girder holding it in place. However — as with designing a bridge girder — it's just as important for engineers to build effective terminal blocks as it is to design the showier parts of the electrical panel.

To make matters more complicated, electrical control cabinets typically integrate hundreds of terminal blocks and related accessories. All those parts are linked by dedicated compatibility rules and specific functions (depending on the application). So, terminal block design is an under-appreciated yet complex process. Fortunately, with some additional CAD software tools, design engineers can simplify the selection process and help ensure they're taking the optimal approach to integrating terminal blocks in their electrical control panel. This type of software

THE INDUSTRY STANDARD FROM ARLINGTON

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SNAP2IT® CONNECTORS

NO TOOLS, SNAP IN • EASIEST CABLE INSERTION • SECURE HOLD

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- **Widest *total* cable ranges** *for our ENTIRE line:* 14/2 to 3/3 *Larger Snap2It connectors also available.*
- **Widest variety of cables** AC90 and ACG90; AC, MC, HCF, MC continuous corrugated aluminum cable, MCI-A cables (steel/aluminum)
- **Easiest cable installation**
- **Fast, secure installation** No pullout
- **Removable, reusable** from cable or box

WIDEST CABLE RANGES FASTEST INSTALLATION!

CATALOG NUMBER	SNAP2IT® CONNECTORS w insulated throat	CABLE OUTSIDE DIA (OD)
38AST	Snap in, 1/2" KO	.405 to .605
3838AST	DUPLEX Snap in, 1/2" KO	.405 to .605, 3/8" Flex*
40AST	RED TINT Snap in, 1/2" KO	.485 to .610
4040AST	RED TINT, DUPLEX Snap in, 1/2" KO	.485 to .610, 3/8" Flex*
4010AST	ANGLED CLIP Snap in, 1/2" KO	.405 to .610

* Flex CSA Listed with anti-short bushing

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Product info aifittings.com/landing/snap2it-complete-series

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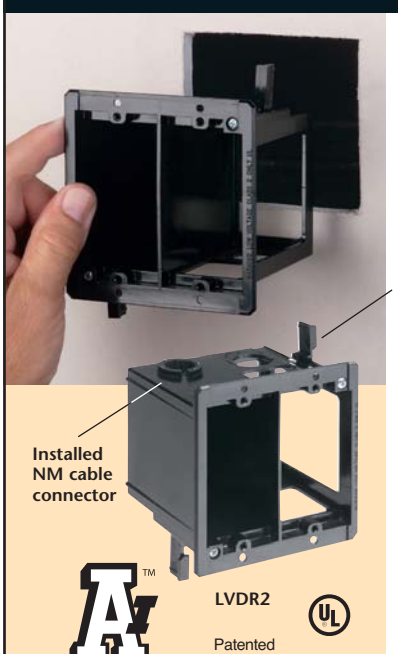
POWER & LOW VOLTAGE

COMBO BOX

FOR RETROFIT PROJECTS



This convenient combo box has power and low voltage openings in the *same box* for a neat, time-saving installation.

The box adjusts to fit wall thicknesses from 1/4" to 1-1/2". Mounting wing screws hold it securely in place.

- 2-Hour Fire Rating
- Low voltage side has a combo 1/2" and 3/4" KO for raceway
- Includes NM cable connector (power side)

Product info aifittings.com/landing/combo-boxes

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LOWEST COST • L-SHAPED

Made in USA

FAN/FIXTURE BOX

SECURE MOUNTING TO SINGLE, DOUBLE JOISTS

Super-secure installation! Our lowest cost, L-shaped fan/fixture box mounts to single or double joists with a captive center screw.

No loose parts! Installation screws ship captive, ready to install box and bracket.

- For 1/2" or 5/8" drywall
- Fast, easy installation
- Locator posts assure proper positioning of fan/fixture bracket
- 2-hour Fire Rating

Patented

Product info aifittings.com/landing/joist-mount-fan-fixture-box

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allows designers to create 2D and 3D tower block assembly drawings so that they can visualize the project more easily. Some terminal block manufacturers even offer these CAD software tools free of charge.

BEST PRACTICES FOR OPTIMIZING ELECTRICAL CABINET DESIGN

If you're trying to make your terminal block design process go more smoothly, here's what to look for when choosing a CAD tool to integrate terminal block design:

- *Look for an interface that's simple to use — ideally one that all project stakeholders can understand.* A simple interface makes it easier to communicate technical specs, which saves time and makes the project more efficient. Ideally, the interface is intuitive enough that a non-specialist could use it to create advanced outputs, manage multiple projects, and create detailed drawings. A good tool will make it simple to generate 2D and 3D marking, export to other CAD systems, and generate the technical file with production drawing, parts list, technical data, and more.
- *Look for software with pre-assembled and pre-marked terminal blocks.* Instead of installing each terminal block one-by-one on the rail, look for a CAD tool that incorporates a complete set of terminal blocks pre-mounted on the rail, pre-marked, equipped with the right accessories, and ready to be installed into the panel. Some components suppliers make this software available to design engineers, who particularly appreciate the time savings that a pre-completed set provides. This option also enables designers to better manage production costs by reducing the manufacturing steps (because there's less assembly operation) and incorporating quality control within the supplier's tool. In addition, designers can also receive support from a components expert.
- *Look for software that includes a 3D parts download platform.* Designers who use their own CAD resources (mechanical CAD for equipment layout purposes) must be able to quickly and easily access the 3D model they want to use. It is much easier to import and use this model if it is available in the native CAD format. Fortunately, some components providers offer high-powered software platforms for downloading 2D and 3D models free of charge. This allows the designer to access complete parts catalogs, generate online models in the desired formats, and import the 3D model into the project.
- *Look for an import and export interface between the electrical CAD and the terminal block assembly design software.* Designers use electrical CAD software to create the electrical circuit diagram of a cabinet. But electrical CAD platforms are designed for global project planning, and don't offer a high level of detail or comprehensive rules dedicated to terminal block assembly. For example, the diagram generated will be basic, showing only the rail, the terminal blocks, and a few simple accessories. To get the level of detail necessary to create a comprehensive bill of materials (BOM), some components suppliers provide an import/export interface that allows for more specialized terminal block assembly. With the interface, detail can be added to the drawing using compatible accessories and drilling plans, and corrections can be made on the fly. Then, once that step is finalized, an accurate BOM can be re-imported into the CAD to supplement the project's main BOM. At the same time, the user can retrieve the complete technical file for the terminal block assembly.

MAKING SOFTWARE WORK HARDER FOR YOU

Since terminal blocks are housed in the electrical panel, they're subject to the same challenges and requirements that modern panels face, including demands for:

- Reduced panel size
- Greater functionality and performance
- Reduced energy consumption

Elkasl919/iStock/Getty Images Plus

Some terminal block manufacturers offer CAD software tools free of charge with their products that allows designers to create 2D and 3D tower block assembly drawings so that they can visualize the project more easily.

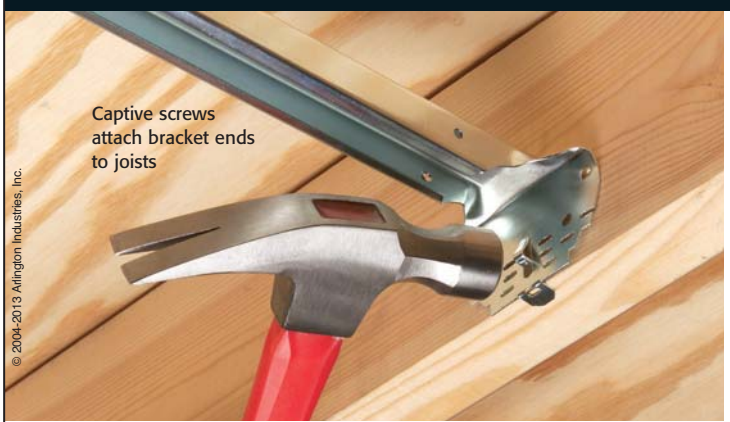
Add to this the very real challenges engineers face on most projects — the push to be more productive and develop faster as well as the need to be agile and responsive to changes in specs and requirements as the project progresses — and you can see why design engineers are looking for ways to optimize the process and gain more efficiency. Thankfully, with a few CAD software tools, designers can optimize their productivity when integrating terminal blocks into the panel. EC&M

Vincent Menager is a technical and training specialist with TE Connectivity. He can be reached at vincent.menager@te.com.

ADJUSTABLE BRACKET • FOR NEW CONSTRUCTION

FAN/FIXTURE BOX

FLUSH CEILING INSTALLATIONS



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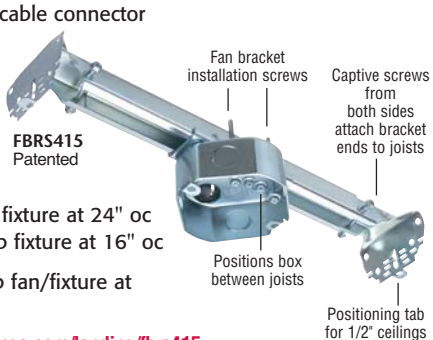
Arlington's heavy-duty, plated steel fan/fixture box has an adjustable bracket that mounts securely between joists spaced 16" to 24" o.c.

Flush ceiling installations
FBRS415 is designed for ceilings up to 1-1/4" thick. For 1/2" ceilings, use the pre-bent positioning tab. For other ceiling thicknesses, bend along the appropriate score line.

- 15.6 cu. inch box ships with captive screws, mud cover, installed NM cable connector



UL ratings
70 lb fan/90 lb fixture at 24" oc
70 lb fan/150 lb fixture at 16" oc

CSA rated 50 lb fan/fixture at 16" and 24"

Product info aifittings.com/landing/fbrs415

SECURE, JOIST-MOUNT INSTALLATION

Made in USA

FAN/FIXTURE PAN BOX

FOR 1/2" OR 5/8" DRYWALL WITH FURRING STRIPS OR HAT CHANNEL

UL rated
70 lb fan • 200 lb fixture
CSA
50 lb fan/fixture

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Arlington's convenient fan/fixture pan box works with 1/2", and single *or double* 5/8" drywall – *on furring strips or hat channel.*

- Easy mounting in new work
- Fan bracket installation screws ship captive until ready for use
- Secure joist-mount installation
- 14.4 cu. in. **UL/CSA Listed**

Patented

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Focus on Connectors

Type 4 Connector

The Cat. 6A PoE Type 4 connector (p/n 106260) is a tool-less connector that will satisfy both the Cat. 6A specification and meet the requirements for PoE Type 4. The connector is rated up to 90W of power and runs PoE across all four pairs. The connector also features a two-piece design, only requires basic wiring tools to terminate, and, according to the company, is compatible with cables ranging from 6.0 mm to 8.5 mm and conductor sizes of 26 AWG to 23 AWG. Additional features include Cat. 6A certification for patch and permanent link, IDC terminal style contacts for wide range of conductor sizes, cable tie for securing cable jacket, and UL 94V-0-rated housing.

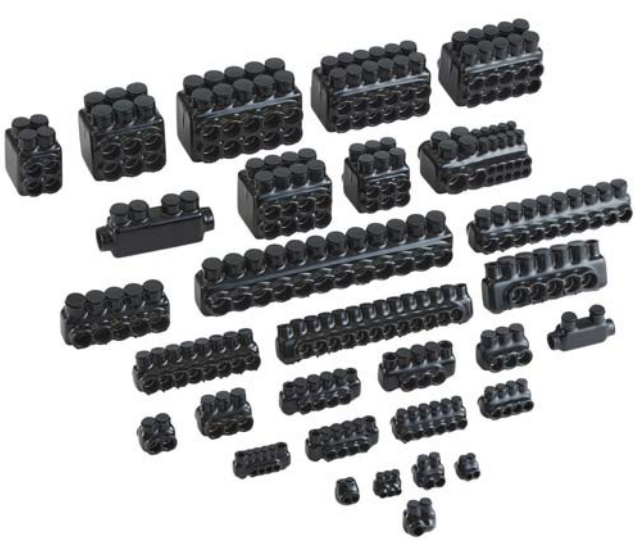
Platinum Tools

Tape Light Connectors

AmpChamp LED tape light connectors are UL recognized and now ship with AmpChamp mounting clips. The clips secure a connector to the mounting surface via two screws, while still allowing access to the terminal screws, and give installers another mounting option in addition to very high bond (VHB) tape. The clips are designed for when VHB tape is not an option. The mounting clips are available for 12 of the company's straight and corner tape light connectors and will be included with those connectors on all future orders.

Alloy LED

Pre-Insulated Connectors



The company behind Polaris pre-insulated connectors have been actively testing sized 350-750 MCM connectors to ensure they are now compliant with 2023 NEC Sec. 230.46 requirements for connectors and devices installed on service conductors. The current compliant 350-750 MCM Polaris connectors from the company include series PL, PLH, IPL, IPLM, IPLMD, IPLD, IT, ISR, IPLH, IPLDH, IPLMDH, ISRH, and ITH.

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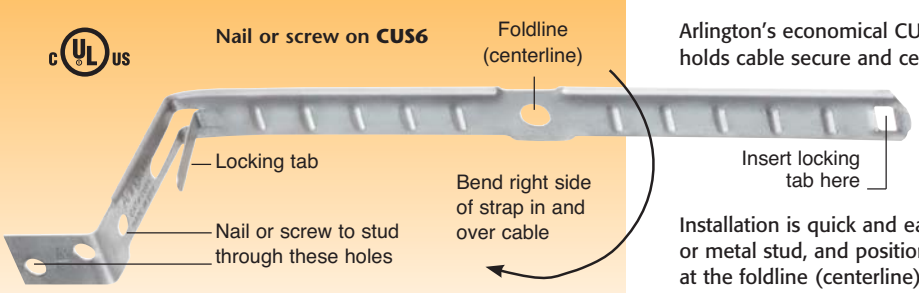

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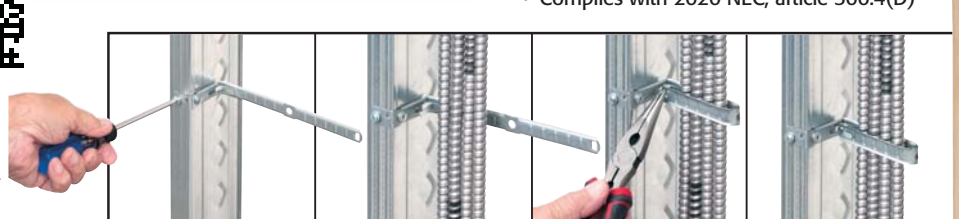
- Complies with 2020 NEC, article 300.4(D)

Holds up to four MC cables centered on a 2x4!



CUS6 holds **FOUR metal cables**...or **SIX NM cables**

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Switchracks

The turnkey, fully customized industrial switchracks serve as electrically and mechanically interconnected, single-point solutions for controlling electrical infrastructure on hazardous or non-hazardous industrial sites. Engineered to global standards, the company's switchracks can be outfitted with motor controls, transformers, circuit breakers, panelboards, and other assorted switching and control equipment, and are designed for single-phase and 3-phase low-voltage power. According to the company, every component on the switchrack is specified according to the applicable ratings of the NEC, ATEX, CEC, IEC, and other standards bodies. Additionally, the product is configured to provide resistance to adverse weather, dust, dirt, and corrosion.
Emerson

Screwdrivers

The company's bare headed nut driver options are designed specifically for electricians, maintenance operators, linemen, and technicians. The product line permits access to equipment with limited clearances, such as terminal blocks and bus bars. The bare headed nut driver options come equipped with double insulated shaft protection, but they do not cover the head, offering additional functionality and enabling access to tighter spaces. The product is 10,000V tested and complies with ASTM F1505 and IC 60900 standards.
Cementex

High-Bay Luminaire

The DC crane vigilant high bay is designed to meet the needs of overhead crane applications. It features a wide 250VDC-480VDC input range with built-in 6kV surge protection and can handle short-term voltage swells of up to 778VDC for at least 60 sec, according to the company. In addition, the luminaires carry additional features to withstand harsh industrial environments, including a copper-free aluminum housing with dual powder coat finish, tempered glass lens, IK 10 impact rating, an ambient temperature range of up to 65°C on most models, and a broad lumen output range of 12,000 lm up to 40,000 lm.
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The box and conduit hanger support plate mounts up to 8-in. × 8-in. junction boxes — both vertically and overhead. A single BCHS-6S can support several boxes and incoming conduit suspended from one threaded rod. This 13.3-in. × 13.3-in. metal plate features offsets for using 1-hole straps, stamped markings for box placement, and several pin holes and slots for attaching 2-hole straps/pipe hangers. The product is UL listed.
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The Fort Wayne work boot features a wrap-over rubber cap and offers flexibility, protection, and traction that blends grit with modern design. Other features include a direct-attached Luftcell air-infused, PU midsole for weightless comfort, a barnyard-resistant leather upper, and the company's KEEN DRY waterproof, breathable membrane. Additionally, safety enhancements include asymmetrical carbon-fiber safety toes that are unobtrusive and 15% lighter than steel as well as a lugged, EH-rated oil- and slip- resistant rubber outsole.
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The outdoor rooftop box is a solution that provides convenient access to power on raised rooftop deck environments. It eliminates the need for extension cords along decking surfaces and provides flexibility in power distribution on rooftops. The box is designed to be installed flush alongside rooftop pavers and features a hinged top self-closing cover. The internal rotating outlet box can be rotated upward when power access is needed and rotates downward when in-use. The rooftop box supports two 20A weather-resistant, GFCI duplex receptacles. The prewired unit comes with receptacles pre-installed and wire leads for wiring up to nearby junction boxes.
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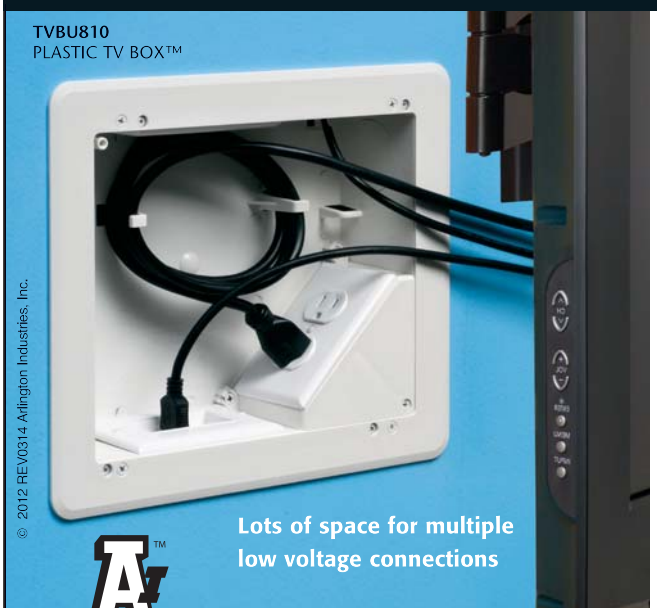

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Mounts to stud in NEW work


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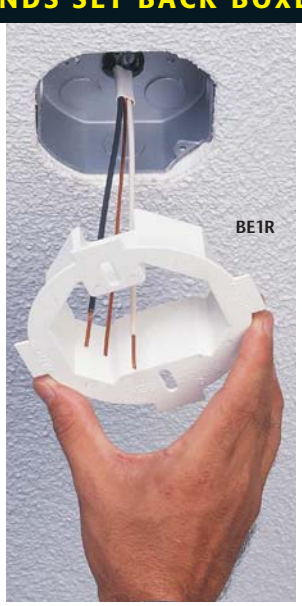

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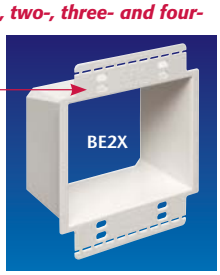

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NEC Requirements for Receptacles

It's easy to commit Code violations with receptacle applications if you don't have a solid understanding of the NEC requirements.

By Mike Holt, NEC Consultant

Article 406 covers the rating, type, and installation of receptacles and attachment plugs. It also covers flanged surface inlets [Sec. 406.1], as shown in **Fig. 1**.

With the 2023 revision, the definitions that previously appeared in Sec. 406.2 have been moved to Art. 100. Here are two that are important to know:

- Child Care Facility. A building (or portions thereof) used for educational, supervision, or personal care services for five or more children seven years in age or less.
- Outlet Box Hood. A housing shield (hood) over a faceplate for flush-mounted wiring devices, or an integral component of an outlet box or faceplate for flush-mounted wiring devices, commonly known as a "while in use" or "bubble" cover.

In regards to receptacle rating and types, they:

- Must be listed and marked with the manufacturer's name or identification and voltage and ampere ratings [Sec. 406.3(A)].
- Of the isolated equipment grounding conductor (EGC) type must be identified by an orange triangle marking on the face of the receptacle [Sec. 406.3(E)]. Isolated ground receptacles must have the grounding contact of the receptacle connected to an insulated EGC installed with the circuit conductors.
- That are nonlocking, 15A or 20A, 125V, and automatically controlled to remove power for energy management or building automation must be permanently marked with the word "controlled" and sport a visible power symbol after installation [Sec. 406.3(F)]. The marking is not required for wall switch-controlled receptacles used for lighting in a dwelling [Sec. 210.70(A)(1), Exception 2].

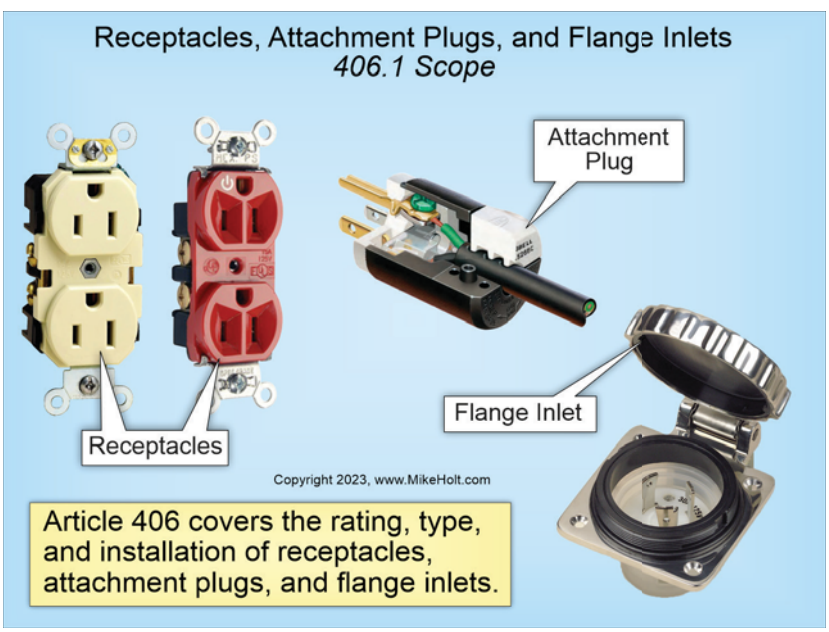

Fig. 1. The rating, type, and installation of receptacles, attachment plugs, and flange inlets can be found in Art. 406 of the NEC.

GENERAL INSTALLATION REQUIREMENTS

Receptacles installed on 15A and 20A branch circuits must be of the grounding type [Sec. 406.4(A)].

The EGC contacts of receptacles and cord connectors must be connected to the equipment grounding conductor (EGC) of the circuit supplying the receptacle or cord connector per Sec. 250.146 [Sec. 406.4(C)].

The branch-circuit wiring method must include or provide an EGC to which the EGC contacts of the receptacle or cord connector are connected.

Note 1: See Sec. 250.118 for acceptable grounding means.

Note 2: For extensions of existing branch circuits, see Sec. 250.130.

REPLACEMENTS

If the receptacle to be replaced is in a location that requires AFCI- and/

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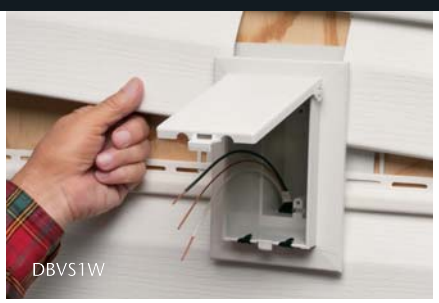

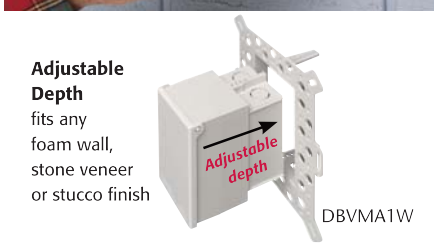

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IN BOX meets 2020 NEC, Section 406.9 *for the protection of exterior outlets which require the use of an extra-duty weatherproof while-in-use cover for all outdoor 15 or 20 AMP receptacles.*

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or GFCI-type receptacles, you must install it in a readily accessible location [Sec. 406.4(D)].

If an EGC exists in an outlet box, replacement receptacles must be of the grounding type, and the receptacle's grounding terminal must be connected to the circuit EGC per Sec. 406.11 [Sec. 406.4(D)(1)].

If an EGC does not exist in the outlet box, replacement receptacles can be: [Sec. 406.4(D)(2)]:

(a) Nongrounding-type receptacles.

(b) GFCI-type receptacles if the receptacle or the cover plate is marked "No Equipment Ground."

(c) GFCI-protected grounding-type receptacles if the receptacle or the cover plate is marked "GFCI Protected" and "No Equipment Ground."

GFCI protection functions properly on a 2-wire circuit without an EGC because the EGC serves no role in the operation of a GFCI device.

The permission to replace nongrounding-type receptacles with GFCI-protected grounding-type receptacles does not apply to new receptacle outlets that extend from an existing outlet box not connected to an EGC.

When existing receptacles are replaced in locations where GFCI protection is required, the replacement receptacles must be GFCI protected [Sec. 406.4(D)(3)].

Exception: Where the outlet box size will not permit the installation of the GFCI receptacle, a GFCI-protected grounding-type receptacle marked "GFCI Protected" and "No Equipment Ground" per Sec. 406.4(D) is permitted.

See Sec. 210.8 for specific locations requiring GFCI protection. Where an NEC rule requires GFCI protection, you can provide that with a GFCI circuit breaker, GFCI receptacle, or a non-GFCI receptacle downstream of a feed-through type GFCI receptacle.

When existing receptacles are replaced in locations where:

- Tamper resistance is required [Sec. 406.12], replacement receptacle(s) must be listed tamper resistant [Sec. 406.4(D)(5)].
- Weather resistance is required, replacement receptacles must be weather resistant [Sec. 406.4(D)(6)].

Fig. 2. Section 555.35(B)(1) contains requirements for GFPE protection of receptacles.

- AFCI protection is required [Sec. 210.12], replacement receptacle(s) must be one of the following [Sec. 406.4(D)(4)]:

(1) Listed AFCI receptacle.

(2) Receptacle protected by a listed AFCI receptacle.

(3) Receptacle protected by a listed combination type AFCI circuit breaker.

Automatically controlled receptacles must be replaced with equivalently controlled receptacles. If automatic control of the receptacle is no longer required, the replacement receptacle must be marked per Sec. 406.3(F) [Sec. 406.4(D)(7)].

Receptacles must be provided with GFPE where replacements are made at receptacle outlets that are required to be GFPE protected per Sec. 555.35(B)(1) [Sec. 406.4(D)(8)], as shown in **Fig. 2**.

MOUNTING RECEPTACLES

Receptacles must be installed in outlet boxes that (unless otherwise permitted in the Code) are securely fastened in place [Sec. 406.5]. Boxes containing a hub can be supported from a flexible cord connected to fittings that prevent tension from being transmitted to joints or terminals [Sec. 400.14 and Sec. 314.23(H)(1)].

Screws used for attaching a receptacle to a box must be a type provided with a listed receptacle or be machine screws having 32 threads per inch.

Faceplates must completely cover the outlet openings [Sec. 406.6]. Metal faceplates for receptacles must be connected to the circuit EGC [Sec. 406.6(B)].

Receptacles:

- In outlet boxes set back from the finished surface must be installed so the mounting yoke of the receptacle is held rigidly to the finished surface [Sec. 406.5(A)].
- In walls or ceilings of noncombustible material (such as drywall) outlet boxes must not be set back more than ¼ in. from the finished surface. In walls or ceilings of combustible material, outlet boxes must be flush with the finished surface [Sec. 314.20]. There must not be any gaps more than ⅛ in. at the edge of the outlet box [Sec. 314.21].
- In outlet boxes that are flush with the finished surface must be installed so the mounting yoke of the receptacle is held rigidly against the outlet box or raised box cover [Sec. 406.5(B)].
- Supported by a cover must be held rigidly to the cover with at least two screws [Sec. 406.5(C)].
- Must be flush with, or project from, the faceplates [Sec. 406.5(D)].
- Installed in countertop surfaces must be listed for countertop applications [Sec. 406.5(E)].

• Listed for work surfaces or countertops can be installed in a work surface [Sec. 406.5(F)].

• Must not be installed in a face-up position in or on countertop surfaces or work surfaces unless listed for countertop surface or work surface applications [Sec. 406.5(G)(1)].

• Must not be installed in a face-up position in the area below a sink [Sec. 406.5(G)(2)].

• Must not be in enclosures with other switches or receptacles if the voltage between the devices exceeds 300V, unless the devices are installed in enclosures equipped with barriers (identified for the purpose) that are securely installed between adjacent devices [Sec. 406.5(J)].

ATTACHMENT PLUGS AND FLANGED SURFACE INLETS

Attachment plugs and flanged surface inlets must be listed for their purpose.

Attachment plugs must be installed so their prongs, blades, or pins are not energized unless inserted into an energized receptacle or flexible cord. A flanged surface inlet must be installed so the prongs, blades, or pins are not energized unless an energized cord connector is inserted into the inlet (**Fig. 3**).

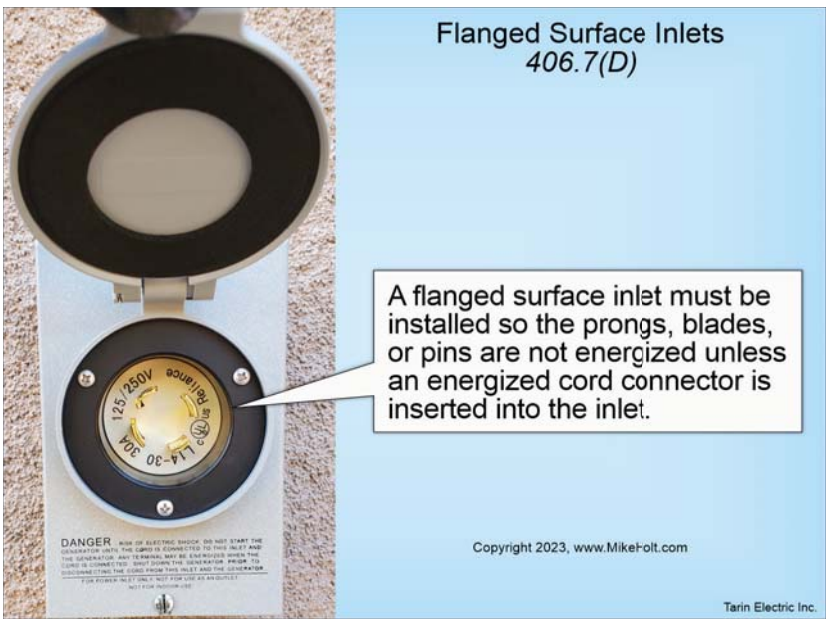


Fig. 3. The requirements for the installation of a flanged surface inlet are found in Sec. 406.(D).

DAMP OR WET LOCATIONS

Receptacles installed in a damp location must be of the weather-resistant (WR) type and installed in an enclosure that is weatherproof when an attachment plug is not inserted (damp location rated), or when the attachment plug is inserted when the cover is closed (wet location rated) [Sec. 406.9(A)]. A damp location is one where a receptacle is located under roofed open porches, canopies, marquees, and the like — and will not be subjected to a beating rain or water runoff.

In addition, 15A and 20A receptacles installed in a wet location must be within an enclosure that is weatherproof when an attachment plug is inserted using an outlet box hood identified as "extra duty" [Sec. 406.9(B)(1)]. Hinged covers of outlet box hoods must be able to open at least 90° or fully open (if the cover is not designed to open 90° from the closed to open position) after installation.

Nonlocking-type 15A and 20A receptacles in a wet location must be listed as the weather-resistant type. Receptacles rated 30A or more installed in a wet location must comply with Sec. 406.9(2)(a) or (b).

> Attachment plugs must be installed so their prongs, blades, or pins are not energized unless inserted into an energized receptacle or flexible cord.

Receptacles cannot be installed within a zone measured 3 ft horizontally and 8 ft vertically from the top of the bathtub rim or shower stall threshold. The zone is all-encompassing and includes the space directly over the tub or shower stall. New with the 2023 revision, these cannot be installed inside the tub or shower stall [Sec. 406.9(C)]. In bathrooms with less than the required zone, a receptacle is permitted on the farthest wall opposite the bathtub rim or shower stall threshold [Sec. 406.9(C) Ex 2].

TAMPER-RESISTANT

Nonlocking-type 15A and 20A receptacles must be tamper resistant "TR" if installed in any of the 10 locations listed in Sec. 406.12. This list has been heavily revised with the 2023 Code.

GETTING IT RIGHT EVERY TIME

Always start a receptacle project by characterizing the location and the application. For example, is it a wet location? Is the application for equipment (no shock protection needed) or humans (shock prevention needed)? As a general rule of thumb, if a receptacle is for an installed machine (e.g., refrigerator) don't use a GFCI. If it's for something a person will handle (e.g., hair dryer) or may contact water (e.g., outdoor location), use a GFCI. EC&M

These materials are provided by Mike Holt Enterprises in Leesburg, Fla. To view Code training materials offered by this company, visit www.mikeholt.com/code.

Stumped by the Code?

By Mike Holt, NEC Consultant

All questions and answers are based on the 2023 NEC.

Q. What are the conditions MC cable can be used and installed?

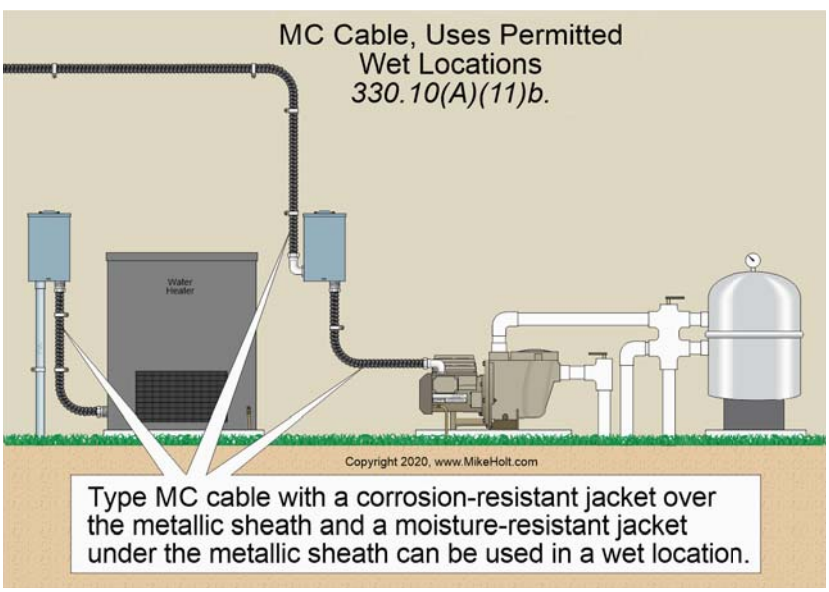
A. The conditions for MC cable can be found in Sec. 330.10.

(A) General Uses. Type MC cable can be used:

(1) For branch circuits, feeders, and services.
(2) For power, lighting, control, and signaling circuits.
(3) For indoor or outdoor locations.
(4) Exposed or concealed.
(5) To be directly buried (if identified for the purpose).
(6) In a cable tray.
(7) In a raceway.
(8) As aerial cable on a messenger.
(9) In hazardous (classified) locations as permitted in Sec. 501.10(B), Sec. 502.10(B), and Sec. 503.10.
(10) Embedded in plaster or brick in dry locations.
(11) In wet locations, where a corrosion-resistant jacket is provided over the metallic sheath and any of the following conditions are met:
   a. The metallic covering is impervious to moisture.
   b. A jacket is provided under the metal covering that is moisture resistant (see the **Figure**).

(B) Specific Uses.

(1) Cable Tray. Type MC cable can be installed in a cable tray in accordance with Art. 392.
(2) Direct Buried. Direct-buried cables must be protected in accordance with Sec. 300.5.
(3) Installed as Service-Entrance Cable. Type MC cable is permitted to be used as service-entrance cable when installed in accordance with Sec. 230.43.
(4) Installed Outside Buildings. Type MC cable installed out side buildings must comply with Sec. 225.10, Sec. 396.10, and Sec. 396.12.



Note: The "Uses Permitted" is not an all-inclusive list, which indicates other suitable uses are permitted if approved by the authority having jurisdiction.

Q. Under what conditions can MC cable not be used and installed?

A. The conditions where MC cable can not be used and installed are found in Sec. 330.12.

Type MC cable is not permitted to be used where:

(1) Subject to physical damage.
(2) Exposed to the destructive corrosive conditions in (a) or (b), unless the metallic sheath or armor is resistant to the conditions or protected by material resistant to the conditions:
   a. Direct burial in the earth or embedded in concrete unless identified for the application.
   b. Exposed to cinder fills, strong chlorides, caustic alkalis, or vapors of chlorine or hydrochloric acids.

Q. What are the NEC requirements for installing MC cable through or parallel to framing members?

A. Section 330.17 contains the requirements for installing MC cable through or parallel to framing members.

Type MC cable installed through or parallel to framing members or furring strips must be protected against physical damage from the penetration of screws or nails by maintaining a 1¼-in. separation or by installing a suitable metal plate in accordance with Sec. 300.4(A), (C), and (D). EC&M

These materials are provided by Mike Holt Enterprises in Leesburg, Fla. To view Code training materials offered by this company, visit www.mikeholt.com/code.

The Importance of Definitive Definitions

Why Code definitions must be clear and easy to understand

By Russ LeBlanc, NEC Consultant

Understanding definitions in the Code is essential for designers, installers, inspectors, and every other Code user for the correct application of requirements throughout the entire Code. Since definitions are so critical, it's important they're as clear and easy to understand as possible.

When it comes to permanently installed swimming pools, revisions were made for the 2023 Code edition to clarify exactly which pools would meet the definition of a "permanently installed swimming pool." For the 2020 and earlier editions, the definition was located in Sec. 680.2 and included pools constructed in, or partially in, the ground. It also included all other pools with a water depth of greater than 42 in., and all pools installed inside of a building, regardless of depth, whether or not they were served by electrical circuits.

What about a pool "installed" in or on the ground? The definition used the term "constructed" rather than "installed." A one-piece fiberglass pool set in the ground by a crane might be considered "installed" rather than "constructed" whereas a pool consisting of walls made of rebar and sprayed-on concrete would probably be considered "constructed" versus "installed." This definition was relocated to Art. 100 and clarified for 2023. The revisions for 2023 removed the 42-in. depth as being part of the definition. So, this definition now includes pools of any depth. The 2023 definition also includes pools that are "constructed" or "installed" in the ground, and it still includes all pools installed inside of a building.

Even with the new streamlined and clarified definition, there may still be some pools that don't quite fit into the definition yet. For example, rooftop pools come to mind. Would a rooftop pool be considered "inside" the building or "on" the building? And does a pool "constructed" inside a building fit into this revised definition? The definition includes pools "installed" inside of a building. Is there a difference between pools that are "installed" inside a building versus "constructed" inside a building? The revised 2023 definition added the words "or installed" when referring to pools in or on the ground but did not add the words "or constructed" when referring to pools inside a building. There are still many questions that will need to be answered when trying to determine which pools will be covered by this definition. I suggest having a professional and courteous discussion with your AHJ to figure it all out. EC&M

Illustrated Catastrophes

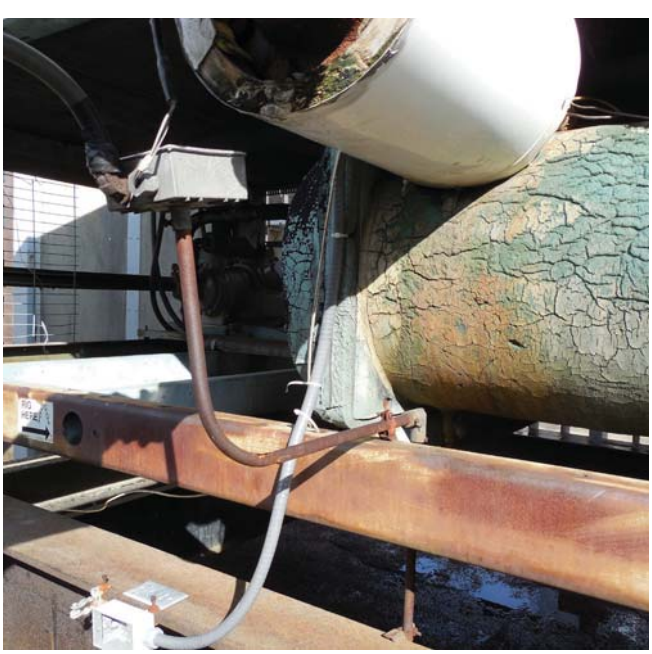
By Russ LeBlanc, NEC Consultant

All references are based on the 2023 edition of the NEC.

RUSTED RACEWAYS

There is not much left of the flexible metal conduit (FMC) that was originally used to wire the lights and switch for this utility room. Excessive humidity has taken its rusty toll on this equipment. The luminaires and switch box are severely rusted too. Section 300.6 requires raceways, boxes, cabinets, elbows, couplings, fittings, supports, support hardware, and other equipment to be made of materials suitable for the environment where they are installed. Perhaps installing nonmetallic raceways, boxes, and luminaires in this humid environment would have prevented the rapid deterioration of the installation. With the FMC completely rusted out, the bonding and grounding connections required throughout Art. 250 are left in doubt. The lack of an effective ground-fault current path as required by Sec. 250.4(A)(5) could lead to an increased risk of shock if there is no way for fault current to return to the source and trip the breaker. The supports for the box have also rusted through, and the box is now hanging by the wires and rusted FMC. I'm sure this box originally complied with the support requirements of Sec. 314.23, but the way it's dangling now creates a violation.

BAD BOX SUPPORT TECHNIQUE



Supporting a box on a single raceway is generally not permitted, but Secs. 314.23(E) and (F) do provide requirements for using raceways to support boxes. For this installation, Sec. 314.23(E) applies. That section permits boxes 100 cu in. or less that do not support a luminaire or contain a device such as a receptacle or switch to be supported by two or more conduits threaded wrenchtight into the enclosure. Each conduit must then be secured within 3 ft of the enclosure — or within 18 in. if the conduits enter the enclosure on the same side. Another problem I see is the use of a set screw type conduit body. For wet locations such as this rooftop cooling tower location, Sec. 314.25 requires boxes, conduit bodies, and fittings to be listed for use in wet locations. I'm fairly certain that this "short L" conduit body is not listed for use in a wet location. Upon close examination of the RMC used to support the box, you may notice the hole rusted right through the raceway near the bottom of the 90° bend. The rust is actually so bad that this raceway is in danger of snapping in half! Section 225.22 requires raceways on the exterior of buildings or structures to be arranged to drain and prevent raceways from collecting water and rusting out like this.

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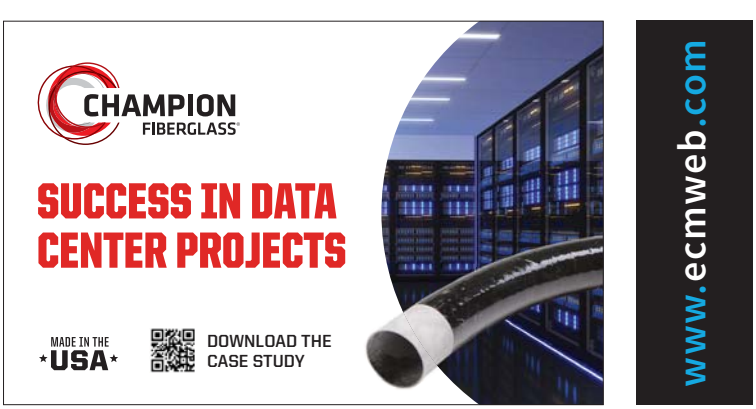

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What's Wrong Here?

By Russ LeBlanc, NEC Consultant

How well do you know the Code? Think you can spot violations the original installer either ignored or couldn't identify? Here's your chance to moonlight as an electrical inspector and second-guess someone else's work from the safety of your living room or office. Can you identify the specific Code violation(s) in this photo? *Note*: Submitted comments must include specific references from the 2023 NEC.

Hint: Piggybacking prohibited!

'TELL THEM WHAT THEY'VE WON...'

Using the 2023 NEC, correctly identify the Code violation(s) in this month's photo — in 200 words or less — and you could win an Arlington Industries 18-in. Slider Bar and plastic box for mounting between studs with non-standard spacing. E-mail your response, including your name and mailing address, to russ@russleblanc.net, and Russ will select three winners (excluding manufacturers and prior winners) at random from the correct submissions. Note that submissions without an address will not be eligible to win.

APRIL WINNER

Our lone winner this month was James Hazelwood, a senior project engineer for 70e Advisors, LLC of Pensacola, Fla. He was able to correctly cite some of the Code violations in this installation.

Section 406.9(B)(1) requires 15A and 20A, 125V and 250V receptacles installed in wet locations to be installed in a weatherproof enclosure. The lack of a cable connector and the broken cover plate certainly do not provide a weatherproof enclosure for the duplex receptacle installed here. Section 406.9(B)(1) additionally requires weather-resistant (WR) type receptacles to be used in wet locations. Section 406.9(A) also requires weather-resistant type 125V and 250V nonlocking receptacles to be used in damp locations too. As best as I could determine, the cable used to provide power to this receptacle outlet is a 2-wire cable and does not contain an equipment grounding conductor. This is a violation of Sec. 406.4(B), which requires the equipment grounding contacts on the receptacle to be connected to an equipment grounding conductor. Since I was only a visitor to this location, I was unable to determine if GFCI protection was provided for this duplex receptacle as required by Sec. 210.8.

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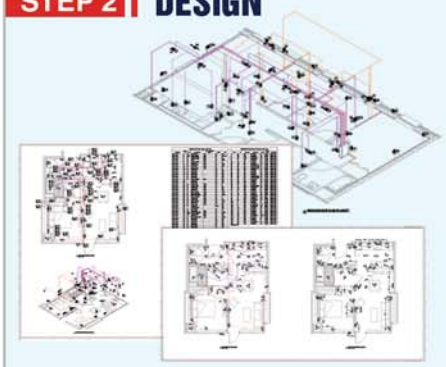

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